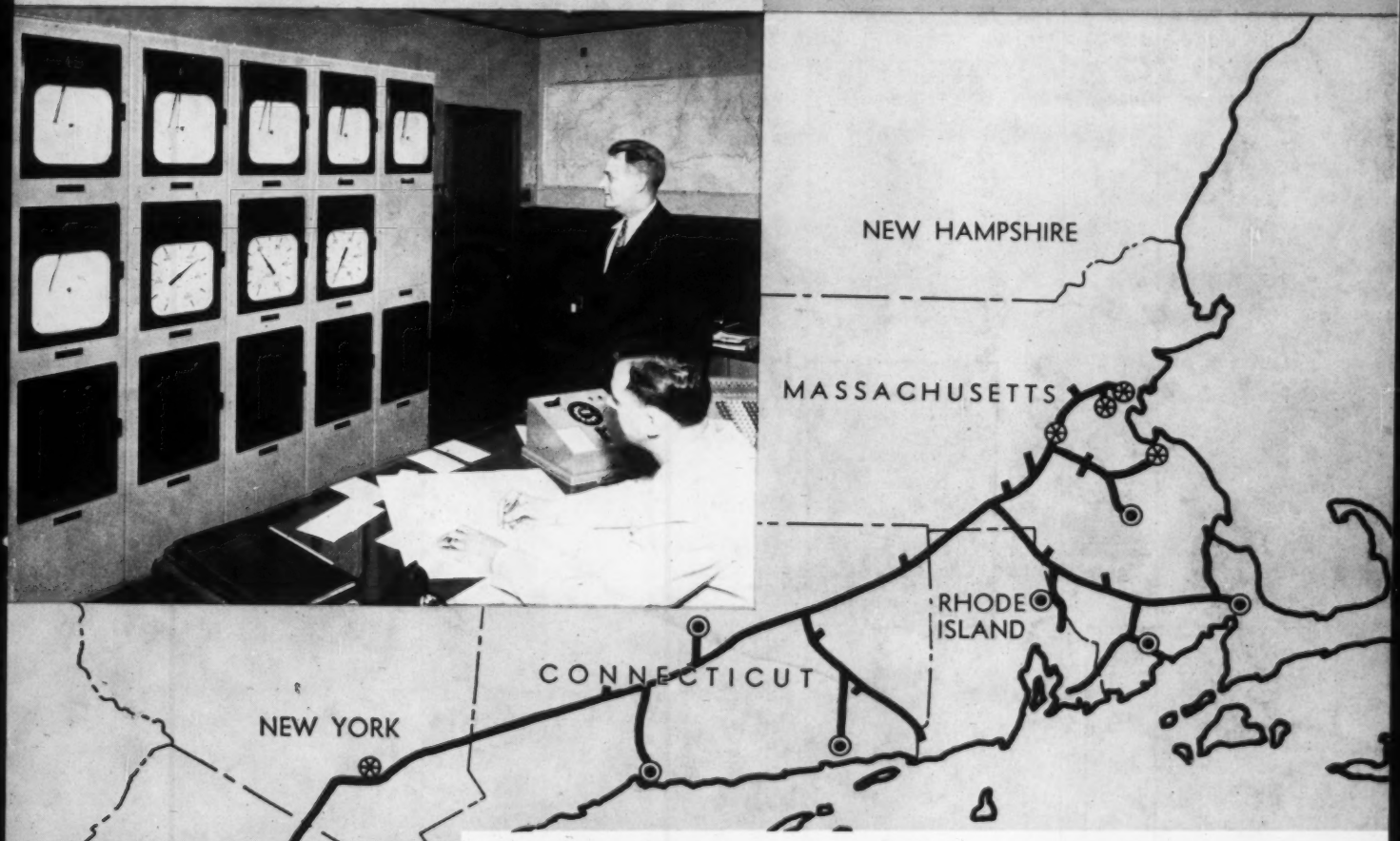
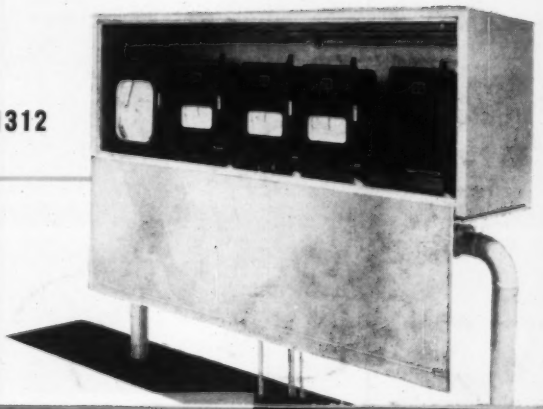
INSTRUMENTS and AUTOMATION

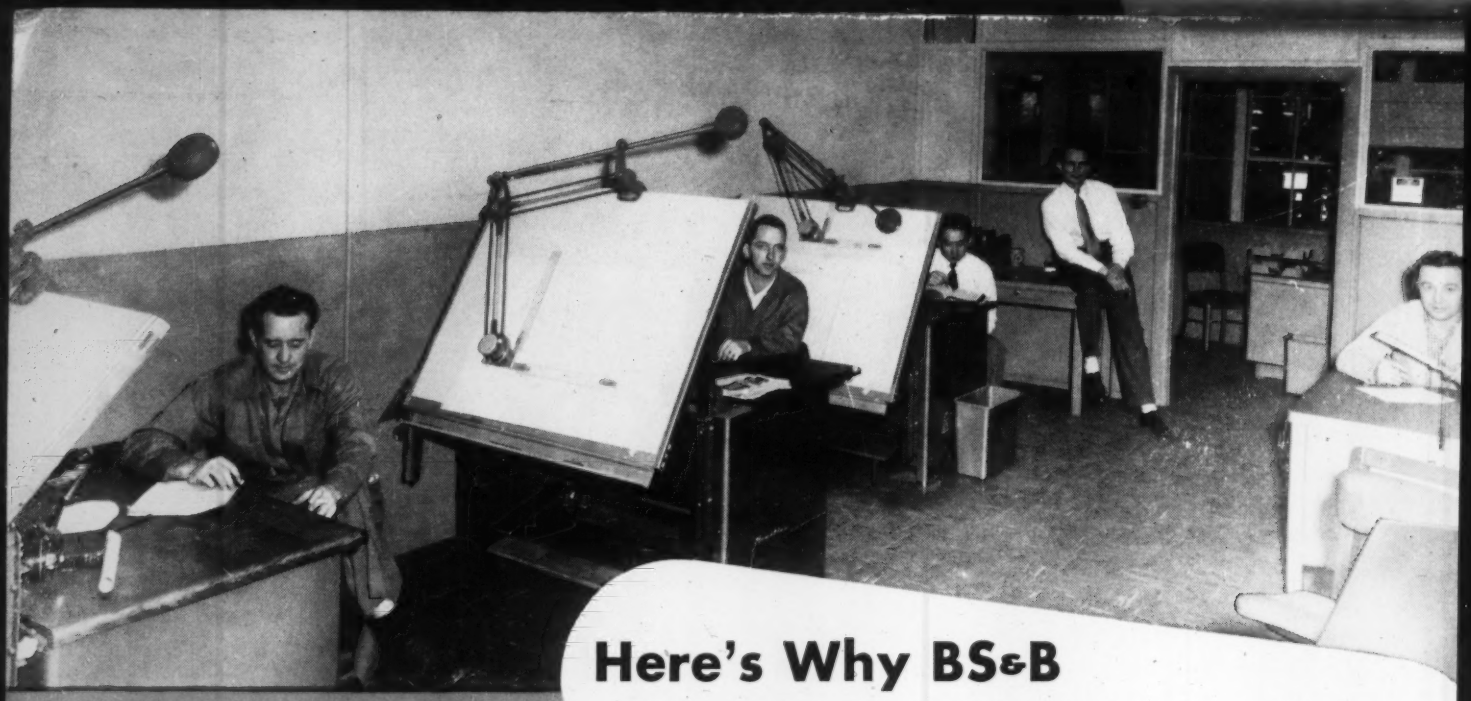
Including: **The Journal of the SCMA** *and* **Simulation Council Newsletter**



Instrumentation of a Natural Gas Pipeline . . page 1312



Vol. 28, No. 8
AUGUST 1955

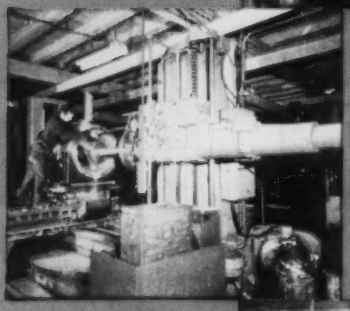


Here in our Tulsa plant, home of Climax Controls, the Product Development Group translates new concepts of automatic control into final engineering drawings for equipment to meet the precise requirements of tomorrow's Process Industries.

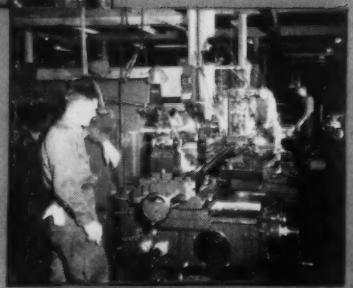
Here's Why BS&B CLIMAX CONTROLS give such *Outstanding Performance!*

Only the most advanced engineering and design...the most modern manufacturing equipment and methods ...the most exhaustive test procedures...and years of practical experience and "know-how" in the industry can combine to produce controls of the quality, precision, long life, efficiency and reliability that you get in Climax! The excellence of BS&B Climax Controls has gained for them a world-wide reputation—for nowhere in the world will you find a better line of automatic process controls...or a company which takes more care and pride in their manufacture! When next you need control equipment for a new installation or for replacement purposes, be sure to specify BS&B Climax...you'll be glad you did!

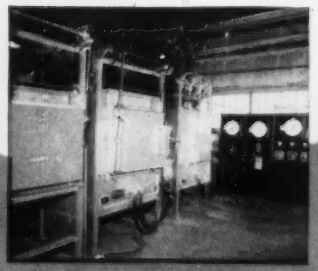
Many different metals are required in the making of Climax Controls. Sizable stocks of steel bars and tubing are maintained in the plant at all times.



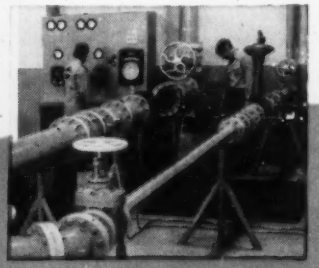
A large investment in highly specialized equipment is required to enable us to manufacture Climax Controls in a full range of types and sizes, from the smallest to the largest.



Our skilled machinists and craftsmen take great pride in their ability to turn out consistently fine quality precision work to the customer's most exacting tolerances.



When required, finished parts are heat treated in these precisely controlled electric annealing furnaces—some of the most modern of their kind anywhere in the world.



To assure maximum on-the-job efficiency, every Climax Control must pass rigorous operating tests in one of the industry's most modern hydraulic and experimental laboratories.

EFFICIENCY
OVER 60 YEARS
BS&B
RELIABILITY

BLACK, SIVALLS & BRYSON, INC.

Climax Controls Division, Dept. 4-V8

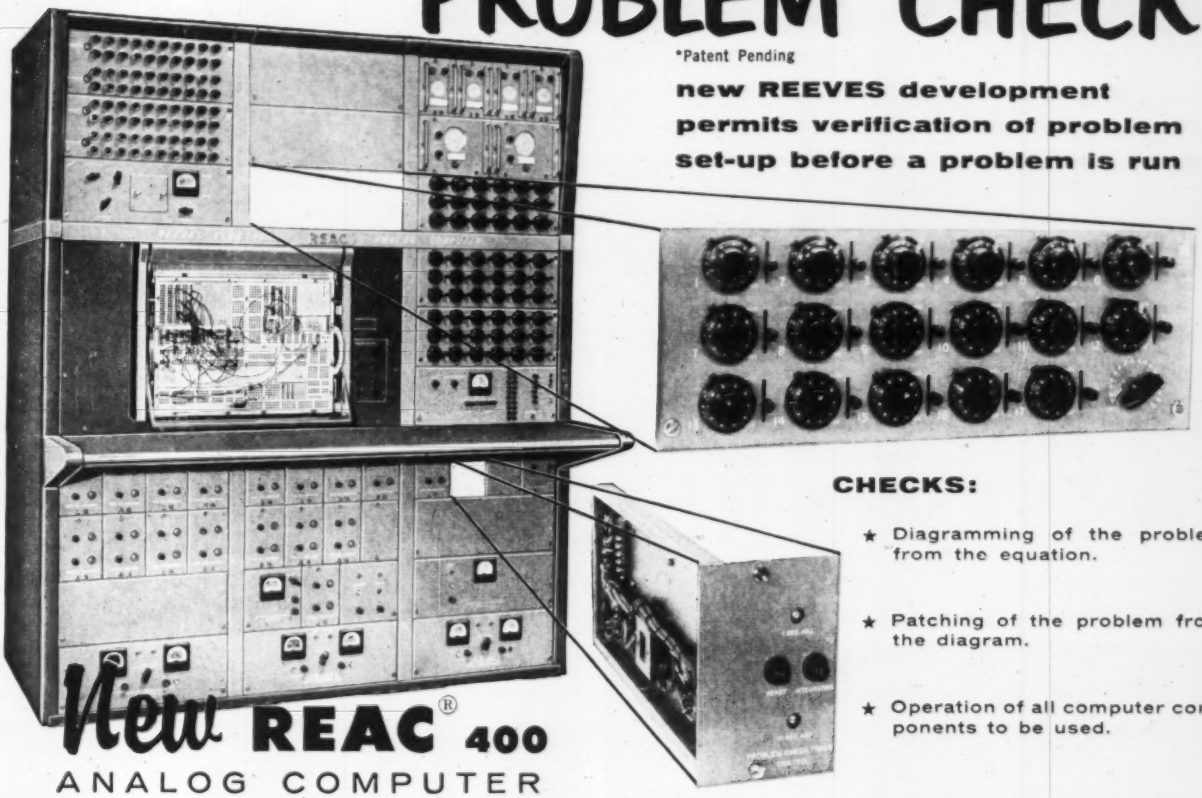
7500 East 12th Street — Kansas City 26, Missouri

For more information circle 1 on inquiry card.

PROBLEM CHECK*

*Patent Pending

new REEVES development permits verification of problem set-up before a problem is run



New REAC® 400
ANALOG COMPUTER

CHECKS:

- ★ Diagramming of the problem from the equation.
- ★ Patching of the problem from the diagram.
- ★ Operation of all computer components to be used.

It's the only economical way . . .

Prepatch boards are, of course, prepared away from the machine. "Problem Check" means that only an absolute minimum of time is required on the machine to check the problem set-up in its entirety. A great deal of expensive checking and cross-checking while the problem is on the machine is thereby eliminated.

"Problem Check" is a new method developed by Reeves to verify analog computer circuits **without disturbing the problem set-up.** Checking is done directly from the equation **before** the problem is run, and the operation of every computing element is checked. Further, if the output of any computing element is not correct, the location of the difficulty is indicated, and the trouble can be quickly and easily found. After "Problem Check," runs may be taken on the machine with assurance that the set-up is correct and that the machine is functioning properly.

REVIEW THESE OUTSTANDING REAC® 400 FEATURES

New HIGH SPEED SERVOS
Servo multipliers have bandwidth over 50 cps. Velocity 1500 v/sec. Six gang pots; two tapped with front panel plug-in turrets for function generation.

New HIGH SPEED RESOLVERS
Vastly improved dynamic performance . . . 35-cycle bandwidth. Rectangular and Polar operation; Full AGC either mode requires no trimming. Front panel plug-in turrets for function generation.

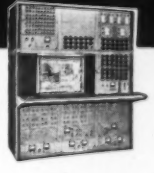
New BUILDING-BLOCK CONSTRUCTION
Permits assembly of computer elements in any desired combination to do particular job or expand existing installation. Completely adaptable to your specific requirements.

New CONVENIENT PATCHBAY
Available in units of 1632, 3264 or 4896 holes for maximum flexibility. Color-coded mask aids in patching. Patchboard changes possible during operation.

New POWERFUL AMPLIFIERS
New dual amplifier chassis, individually chopper-stabilized. Noise less than 3 mv rms in cabinet. Phase shift 0.075° @ 100 cps. in cabinet. Bandwidth over 10 KC in cabinet.

Reeves INSTRUMENT CORPORATION

REEVES INSTRUMENT CORPORATION
A Subsidiary of Dynamics Corporation of America
225 East 91st St., New York 28, N. Y.


REAC Analog Computers

Precision Floated GYROS

Precision RESOLVERS and PHASE SHIFTERS

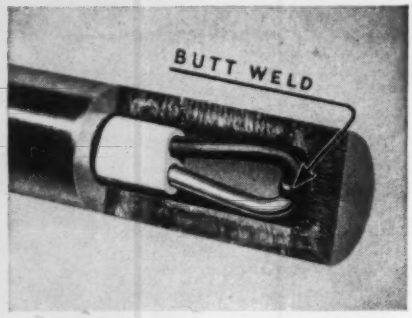
SERVO MECHANICAL PARTS

3RV88

For more information circle **2** on inquiry card.

Brown Butt-Welded Thermocouples have faster response ...better accuracy

TAKE a close look at the way the two wires are joined in a Brown thermocouple. This unique construction makes a big difference in the performance you get in temperature measurement. Instead of the usual twisted and welded joint, these couples are made by butt-welding the wires in a small but rugged junction . . . which gives these unusual characteristics:



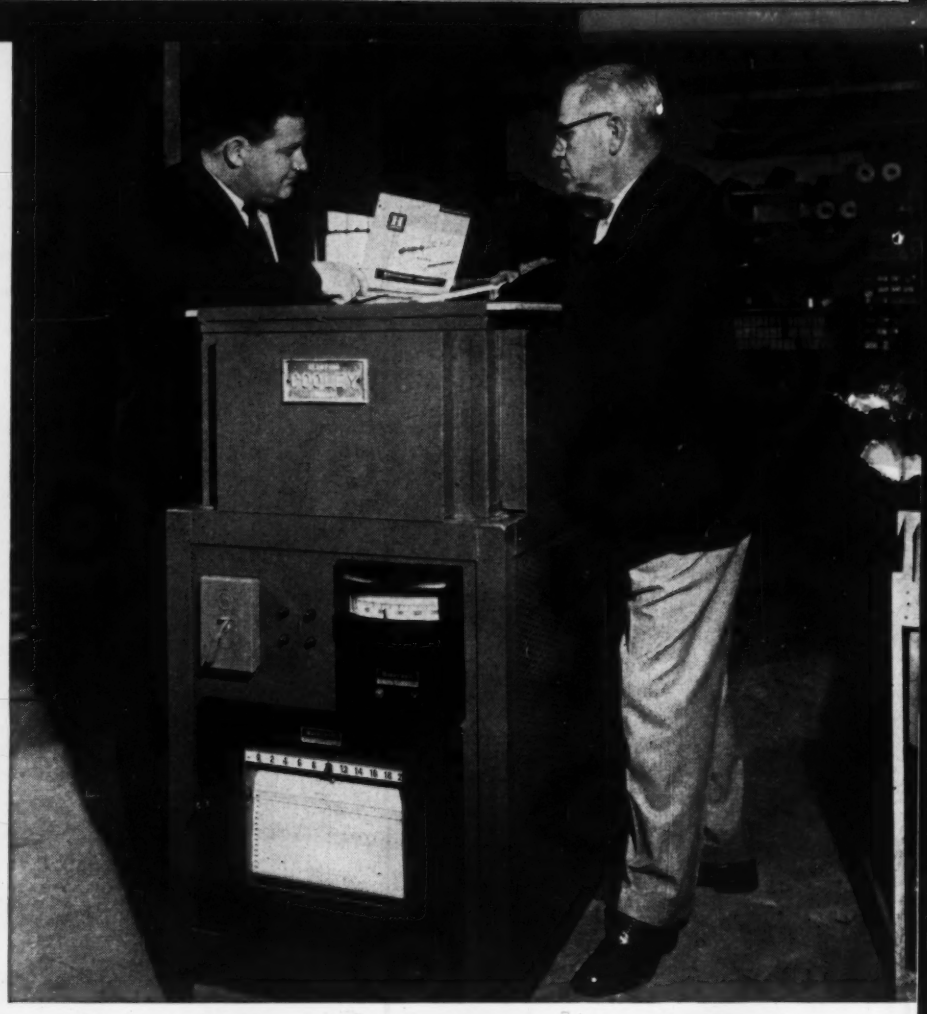
Smaller mass for faster response. Only slightly larger than the diameter of the wire, the butt-welded junction heats and cools far faster than conventional twisted joints.

Improved accuracy is obtained by the curved design of the wires, which minimize heat conduction away from the junction to the insulators.

"Dead air space" eliminated. The junction makes metal-to-metal contact with the bottom of the tube or well. Heat thus is conducted directly to the measuring junction, without the lags and errors of air conduction.

The overall result is that the Brown Butt-welded thermocouple is from 1⅓ to 9 times as fast as conventional couples!

Your HSM will be glad to give you complete data on the many sizes and styles in which these thermocouples are supplied, and to help you choose the most effective model for your specific application.



Here's why it pays to know your HSM

HONEYWELL SUPPLIES MAN

W. A. (BILL) GILL (*left*), Honeywell Supplies Man in the Indianapolis area, discusses features of Brown butt-welded thermocouples with W. B. Cooley, president of Cooley Electric Manufacturing Corporation . . . explains how the extra speed and accuracy of this couple design can be utilized in special Cooley calibrating furnaces.

Personalized help in selecting pyrometer supplies from the comprehensive Brown line is only one of the benefits to be gained from the HSM Plan. Equally important are its contributions to economy and convenience, through planned purchasing of all pyrometer supplies your plant needs.

Ask your local HSM to show you how this plan can work for you . . . as it has for hundreds of other plants. Call him at your local Honeywell office . . . as near to you as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

● **REFERENCE DATA: Write for Pyrometer Supplies Buyers' Guide No. 100-G...and for the booklet, "The HSM Plan."**

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

For more information circle **3** on inquiry card.

Contents...

INSTRUMENTS and AUTOMATION

Vol. 28, No. 8 August 1955

Richard Rimbach, Publisher
Milton H. Aronson, Editor
Manoel F. Behar, Editor Emeritus
James Emge, Associate Editor
David S. Aland, Associate Editor
Milo D. Pugh, Western Editor
John H. McLeod, Jr., Associate Editor (Simulation Council Newsletter)
Armand T. Gaudreau, Consulting Editor (Automation)

District Offices and Managers

Altadena, Calif., Milo D. Pugh & Associates: M. D. Pugh, 2721 N. Marengo Ave., SYcamore 7-2894; Hunter Vinton, 1050 Lincoln Ave., Palo Alto, Calif., Davenport 5-4815

Boston 16, Mass., Harold H. Short, Jr., Holt Road, Andover, Mass., Andover 2212

Chicago 1, Ill., Harold W. Haskett, Room 1205, 228 N. La Salle St., Central 6-8963

Cincinnati 5, Ohio, Harold W. Haskett, 742 Elberon Ave., Grandview 1-4323

Dallas, Texas, Edward F. Wright, 505 N. Ervay, Rm. 310. Prospect 0189

Kansas City 6, Missouri, Thomas W. Wright, 18 East 11th St., Telephone BAltimore 7305

New York 17, N. Y., Richard Rimbach, Jr., 525 Lexington Ave., Rm. 359, Murray Hill 8-0980

Philadelphia, Pa., Robert H. Maxwell, 7 Wilde Ave., Drexel Hill, Pa., Clearbrook 9-4342 (Phila. Suburban)

Pittsburgh 12, Pa., C. Goldcamp, 845 Ridge Ave., Fairfax 1-0161

St. Louis 1, Mo., Stephen E. Wright, 706 Chestnut St., Chestnut 1-1965

London. W.1, England, John C. N. Hughes, Crown House, 143-147 Regent St., Regent 3891

SUBSCRIPTION RATES
For One, Two, and Three Years

	One Year	Two Years	Three Years
United States, U.S. Possessions and Canada	$4.00	$7.00	$ 9.00
Latin America and Australia	5.00	8.00	12.00
Belgium, Denmark, France, Great Britain, Holland, Italy, Norway, Portugal, Spain, Sweden, Switzerland and West Germany	6.00	10.00	15.00
Austria, Bulgaria, China, Czechoslovakia, East Germany, Hungary, India, Poland, Romania, Russia and Yugoslavia	10.00	16.00	24.00

MEMBER ABC Audit Bureau of Circulation.

Payments from outside the U. S. A. must be in the form of an International Money Order or check on a U. S. Bank.

Position and company connection as well as products manufactured must be indicated in all subscription orders.

SPECIAL FEATURE

Tenth Annual Instrument Exposition Exhibitors and their Products 1243

Editorial

Automation and Culture 1241

References on "Ice Point" 1242

ISA Conference and Exposition 1242

The Simulation Council Newsletter 1307

Feature Articles

Instrumentation of a Natural-Gas Pipeline 1312
by Walter E. Rufleth

Process Control Analysis 1316
by Millard H. Lajoy and E. Allen Baillif

Instrument Markets Abroad 1319
by Richard Rimbach

Telemetered Temperatures 1320
by A. B. Kaufman

Test Stand for Panel Indicators 1323
by Fred J. Lingel and V. T. Burkett

Measurement of Temperature Coefficient of Resistance 1324
by H. Philip Hovnanian

A Chemical Plant Program for Instrument Personnel Training 1327
by William D. DeCourcy

Electronic Circuitry 1330
by Charles F. Kezer and Milton H. Aronson

Selection of Instrument Rectifiers 1332
by Edward L. Pagano

Counters Provide Direct Readout in this Recording Accelerometer 1334
by E. J. Kirchman

Journal of the Southern California Meter Association

Electronic Controllers 1338
by Jack L. Gates

Other Regular Features

Trends 1185
Stock Report 1186
News 1194
New Instruments 1256
Events Calendar 1304
Test Your I.Q. 1342
Briefs 1344
New Literature 1356
Advertiser's Index 1370
Searchlite Section 1372
Inquiry Card 1373

Copyright 1955, published monthly, by The Instruments Publishing Company, Inc. Office of publication, 1600 North Main Street, Pontiac, Illinois. Executive and Editorial Office, 845 Ridge Avenue, Pittsburgh 12, Pennsylvania. Entered as second class matter January 26, 1932, at the post office at Pittsburgh under the Act of March 3, 1879. Transferred permit October 14, 1949 to the post office at Pontiac, Illinois, under the act of March 3, 1879.

G-E PRECISION INDICATOR is available as a single-point or multiple-point instrument. For multi-point instruments different types of switches are available. The toggle type, pictured above, is either locking or non-locking, according to specifications. The push-button type remains in a depressed position until another button is pushed. The large easy-to-read scale supplies quick temperature readings for accurate records and makes logging a simple job for the operator. For further information contact your nearest G-E representative or send in coupon at the right.

USE G-E PYROMETERS FOR ACCURATE CONTROL

General Electric Pyrometers Give Dependable Protection

TYPE HP-3 PYROMETER, a two-position controller, has positive control action, initiated by 0.1 percent in full scale movement of instrument pointer. This gives accurate readings from easy-to-read 7-inch scale. Units are available for flush or surface mounting. Indicator, controller, and protector units are plug-in type, permitting easy servicing.

New G-E Precision Indicator Makes Temperature Checks Quick and Easy

New G-E Instrument Gives Finger-tip Scanning of up to 48 Process Temperatures in Helping You Maintain Accurate Product Control

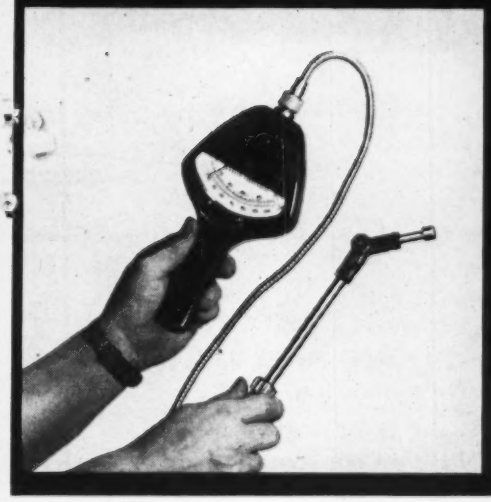
General Electric's new precision indicator scans, by manual switching, from 1 to 48 process temperatures on multi-installations of thermocouples or resistance-bulb circuits. The new G-E potentiometer features a wide temperature range scale and is a high-accuracy, null-balancing instrument.

NEW G-E INDICATOR assures you of having less maintenance by eliminating conventionally used dry cells, slidewire and sliding contacts. This excludes such time-consuming jobs as replacing dry cells, or cleaning moving contacts.

THE MAGNETIC STANDARD provides truly continuous standardization through a revolutionary measurement-circuit design, which incorporates the high stability of a permanent magnet for a reference standard. Loss of measurement and control during standardization periods can never be experienced with constantly balancing G-E system.

G-E RECORDING CONTROLLER has same measurement-circuit design as precision indicator. Long term accuracy and precision of measurement are assured, and you get continuous dependable control with truly continuous standardization.

G-E HAND PYROMETER DESIGNED FOR WIDE USE



GENERAL ELECTRIC COMPANY
SECTION C587-1
SCHENECTADY 5, NEW YORK

Please send me a copy of the interesting and colorful bulletins checked below:

- ☐ GEA-6020 Hand Pyrometer
- ☐ GEC-713 Thermocouple and Accessories
- ☐ GEC-1311 Type Precision Indicator
- ☐ GED-2100 New Recording Controller

Name .....
Company .....
Street .....
City ..... Zone ..... State .....

DUAL-RANGE General Electric hand pyrometer is designed for more flexible and inexpensive measurement of gas, surface and molten-metal temperatures.

EASY-TO-USE hand pyrometer accurately indicates temperature of precision castings. The instrument is light in weight with a non-slip, bayonet-grip handle.

Progress Is Our Most Important Product

GENERAL ELECTRIC

For more information circle 4 on inquiry card.

PROVEN by 8 years

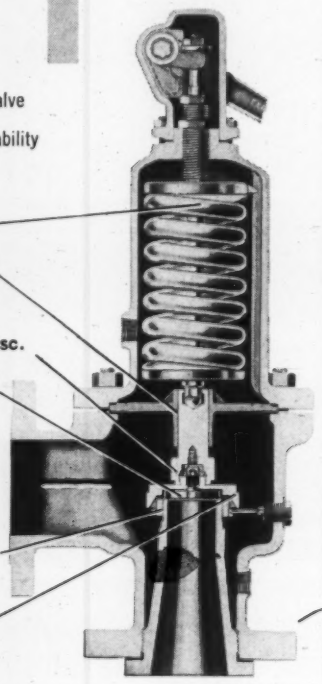
THOUSANDS of Successful Installations of Farris "4 in 1" Safety Relief Valves*

NOTICE: Farris Safety Relief Valves, the Internal Heat Exchanger, and Bellows construction are covered by U.S. Patents and Patents Pending. Copyrights, where applicable, are registered.

1 STANDARD FULL NOZZLE SAFETY RELIEF VALVES

Here is the ultimate in nozzle valve construction with complete standardization and interchangeability in every part:

- Round wire springs calibrated for rating.
- 2½ to 1 guiding ratio, close tolerances.
- Alignment spool for perfect alignment and bearing from stem to disc.
- Self-aligning, optically-flat replaceable disc of forged Stainless Steel.
- All bearings of hardened Stainless Steel.
- Expanded orifices increase capacity.
- Single blowdown ring does not affect capacity —simple adjustment.
- Flared disc-holder for ultimate operating efficiency.



BALANSEAL© SAFETY RELIEF VALVES

BalanSeal construction isolates all working parts. It consists of a neutral area bellows equalling the area of the seating surface, incorporating a mechanically-held seal for the lower part to greatly enhance replacement. BalanSeal can be simply installed any time. Because BalanSeal neutralizes effects of back pressures, resulting in a constant, safe relieving point on the upstream side, size of back pressure piping can be drastically reduced—for pipe savings up to 15 times the cost of the valve! Where accurate set points must be depended upon, BalanSeal stands alone.

For eight years Farris has been setting-the-pace-in-safety with "4-in-1" Safety Relief Valves, the "standard" for long service life, minimum maintenance and positive protection.

Farris' recognition as the pace-setter of the industry is no accident, but the result of many engineering "firsts" in improved valve design—FIRST with balanced bellows construction . . . FIRST to offer multiple nozzle sizes within one valve . . . FIRST with a line of bar stock safety-relief valves for pressures to 10,000 lbs. . . . FIRST to offer internal heat exchangers . . . FIRST to offer realistic pricing, giving the customer the benefit of manufacturing economies . . . and only Farris can point to proved-in-service performance . . . because Farris is the pioneer manufacturer of safety relief valves with bellows.

FOR ENGINEERS: Catalog 48Ra on the full line of Farris Safety Relief Valves; and Technical Manual 51B—"Principles of Manifold Discharge Piping". Available on request.

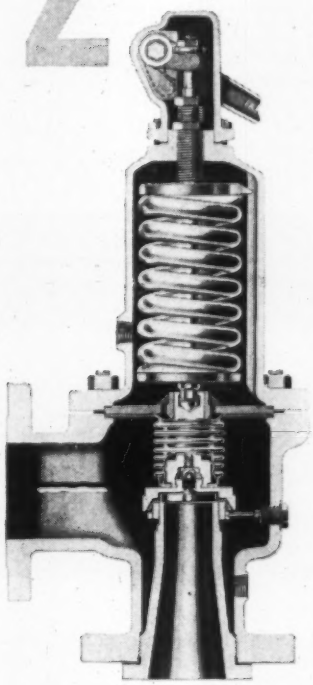
For more information circle 5 on inquiry card.

"THE FOX AND THE HARE"

Send for this popular entertaining pamphlet presenting a story about the recognition of BALANSEAL valves. It is humorous and enlightening. Just ask for it by name.

# of ACTUAL SERVICE

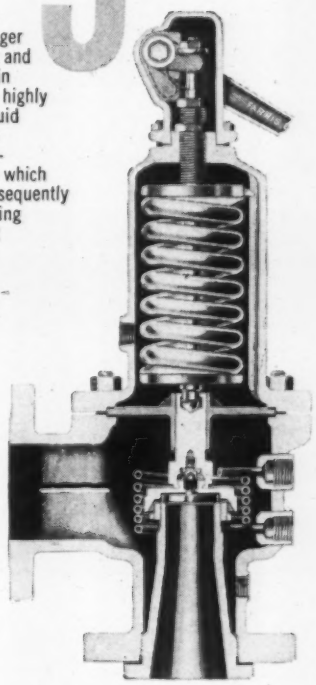
2



INTERNAL HEAT EXCHANGER

The exclusive Farris Internal Heat Exchanger eliminates inefficient and costly steam tracing in a valve body to keep highly viscous media in a fluid state. It consists of a stainless steel coil inserted in the body to which steam is fed and subsequently trapped out. For placing heat where it is most effective, increasing efficiency, lowering steam consumption, the Farris Internal Heat Exchanger is the only available product of its kind.

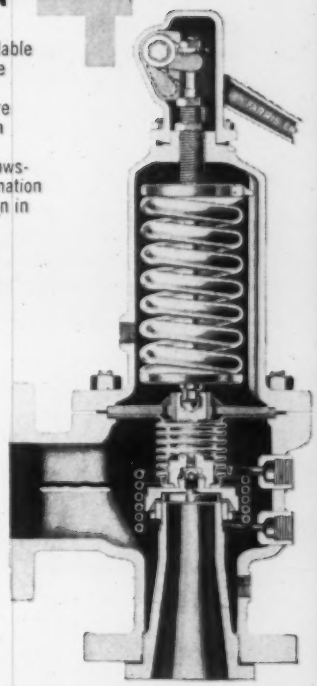
3



BELLOWS—HEAT EXCHANGER COMBINATION

For completely dependable valve operation in spite of sticky fluids (tars, asphalt, etc.) and where complete freedom from contamination is required, select the Bellows-Heat Exchanger combination . . . The ultimate design in safety relief valves for applications where material is highly viscous. All parts are Farris Standard construction.

4



***CERTIFIED AND APPROVED by the National Board of Boiler and Pressure Vessel Inspectors, complying with ASME requirements. Tests made at university laboratories by independent observers. Certification data available on request.**

and Still the Lowest Prices in the industry!

Coming Soon!

An added line of ultimate capacity nozzle valves

Farris ENGINEERING CORPORATION

415 COMMERCIAL AVE., PALISADES PARK, NEW JERSEY

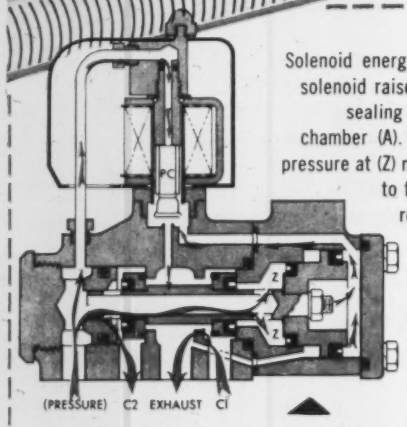
Affiliates: Farris Flexible Valve Corp. • Farris Stacon Corp. • Farris HydroTorque Corp. Farris HydroSeal Corp. • Farris Pickering Governor Co.

For more information circle **5** on inquiry card.

5 major advances in a 4 way SOLENOID VALVE

1. Absolutely tight seating on air or liquids
2. Safe, positive operation
3. Single or dual Solenoids — for circuit design versatility
4. Mountable in any position; operates up to 850 cycles/minute
5. Simple design — easy maintenance

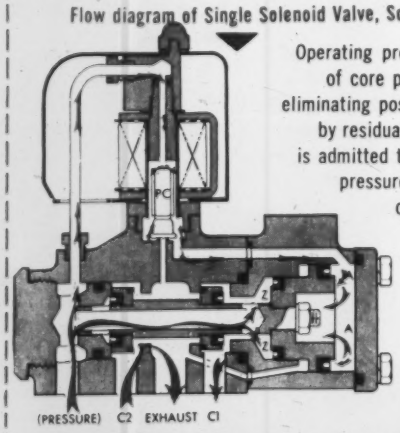
See these valves and other products at our booth (A-103-104) during the 10th Annual Instrument Conference and Exhibit.



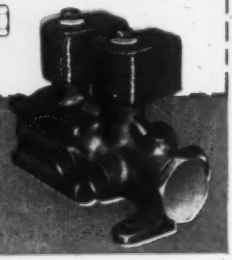
Solenoid energized — energizing the solenoid raises the pilot core (PC) sealing the pressure inlet to chamber (A). (A) is exhausted and pressure at (Z) moves the valve piston to the right. Pressure on resilient inserts forces them against the metallic junction of disc and seat in an absolutely tight seal.

Flow diagram of Single Solenoid Valve, Solenoid Energized

Flow diagram of Single Solenoid Valve, Solenoid De-energized



Operating pressure applied to top of core pushes it off the seat, eliminating possible sticking caused by residual magnetism. Pressure is admitted to (A). While the same pressure exists on both sides of the piston, (A and Z) the area on the right is greater. The resultant force moves the piston to the left.



DUAL SOLENOID VALVE — added safety feature! Locks into position on power failure; coil must be energized for piston movement.

Designed to function perfectly at speeds far in excess of normal requirements, this new 4-way, poppet-type ASCO Valve makes possible a fresh approach to design engineering. It is especially applicable for punch presses, welding machines, machine tools, indexing operations, and air operated clutches and brakes.

1. **ABSOLUTELY TIGHT SEATING** is assured — with no grinding, lapping or close adjustments. ASCO overcomes the leakage factor that was inherent in the earlier slide valves with a completely new design principle. Valves have been operated for many millions of cycles with no leakage on air!

2. **SAFE, POSITIVE OPERATION** is provided by the unique pilot action, poppet-type construction and power operation in both directions; piston malfunctioning caused by residual magnetism or binding is eliminated. No return springs are used; fluid pressure alone activates the valve.

3. **SINGLE OR DUAL SOLENOID VALVES** in ⅜" to 1" pipe sizes.

4. **MOUNTABLE IN ANY POSITION,** this valve will operate up to 850 cycles/min. Available with standard, water-tight or explosion-proof solenoid enclosures; JIC construction is also provided.

5. **SIMPLE IN DESIGN,** it has only two moving assemblies — the pilot core and the valve piston. Operating parts are accessible—NO SPECIAL TOOLS ARE NEEDED.

There's one source that solves virtually any solenoid valve problem — ASCO. Have the ASCO Engineer call — or write today for complete data on the Single and Dual Solenoid Bulletin 8344.

ASCO®

Solenoid Valves

Automatic Switch Co.

For more information circle **51** on inquiry card.

Condensed
Catalog
of
Components

Swartwout Autronic® CONTROLS

all-electronic control system

for process and power instrumentation

speed
accuracy
compactness
interchangeability
ease of installation
low maintenance

THE SWARTWOUT COMPANY • 18511 EUCLID AVENUE • CLEVELAND 12, OHIO

SWARTWOUT AUTRONIC CONTROL SYSTEM

The Autronic Control System is the first miniature *all-electronic* control system for process and power instrumentation. It is the most flexible system in existence with its ability to use a-c, d-c, or motion inputs, as well as conventional primary elements. No matter how stringent the requirements for accuracy, speed, reliability and compactness, it provides a degree of control never before available.

In the Autronic System, process variables are converted into small voltages by primary sensing elements. These voltages are transmitted to the centrally located Autronic Controller where they are continuously modulated by electronic means. The resulting voltage is transmitted electrically to the final element or transducer. The Controller can be located at any convenient point. Cable length is unimportant and signals can be run up to distances of 15,000 feet.

SIGNAL TRANSMISSION

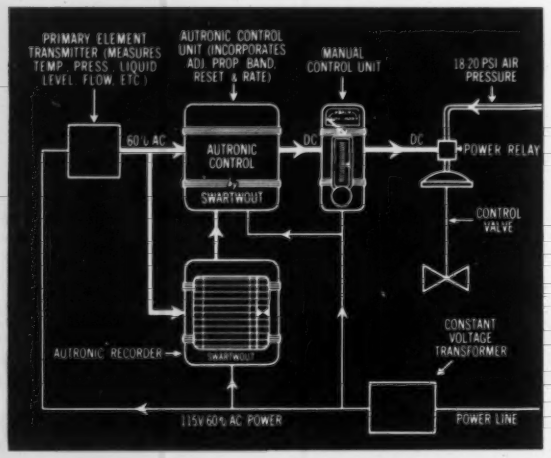


Fig. 1 – Typical schematic diagram.

Transmission of information throughout the Autronic System is instantaneous because it is entirely electrical. From primary element to final element there is no mechanical motion . . . no slide wires or motors . . . no booster mechanisms or other delicate equipment to overcome distance effects . . . no trouble from air leaks or frozen air lines. Transmission wires are quickly, easily installed without special precautions. Because primary elements always produce a voltage which is the same for all elements, Autronic Controllers and Recorders are interchangeable in the field without recalibration.

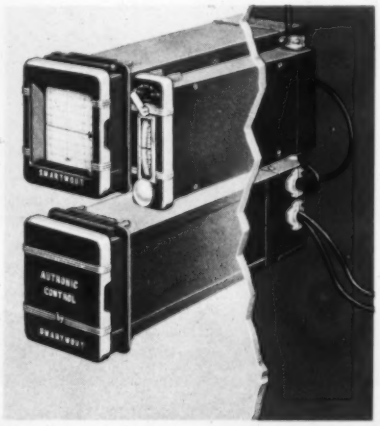


Fig. 2 – Phantom view of Autronic Controller, Recorder, and Manual Control mounted in panel.

AUTRONIC CONTROLLERS

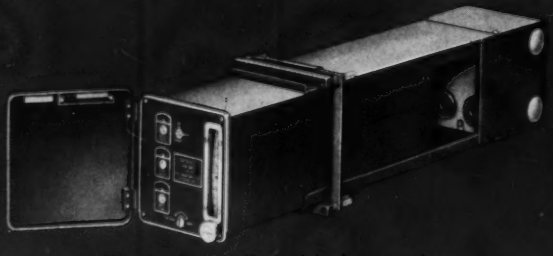


Fig. 3 – Controller with dustproof case partially pulled out of mounting frame.

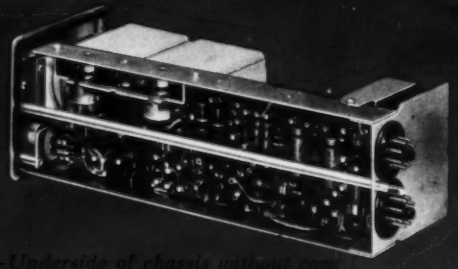


Fig. 4 – Underside of chassis without case showing plug-in connections.

The Controller is the heart of Autronic System. Featuring all-electronic operation, there are no moving parts, slide wires or boosters to initiate control action. Input to the Controller is a 0.0 to 0.500 volt a-c signal direct from the primary element and is always the same whether temperature, pressure, level, flow or other variable is being controlled. The Controller continually modulates the input voltage by electronic means and converts it to a direct current to operate final element. Response is instantaneous and operation stepless.

Sensitivity—Infinite because there are no moving parts to cause friction.

Speed of Response—Extremely rapid because there is no air, no mechanically moving parts to cause time lags or friction, no inertia to overcome.

Accuracy—Tracking between Controller and set-point is within ±.5%. Controller resets within ±.25% of proportion-band setting.

Hysteresis—Zero.

Power Consumption—25 volt-amps. 115 volts a-c 60 cycle.

STANDARD ADJUSTMENT RANGES

Proportional—Continuous screwdriver adjustment from 3 to 200% proportional band.

Reset—Screwdriver adjustment in 17 logarithmic steps from .03 to 20 or .4 to 240 repeats per minute. Each step gives approximately same change in performance regardless of reset adjustment. Reset can be turned off by switch on Controller face.

Rate Action—Screwdriver adjustment in 11 steps from .05 to 8 or .004 to .7 minutes rate time. Twelfth position makes rate action inoperative.

Set-Point—(Optional on Controller.) Knob adjustment for edge-reading calibrated dial.

Autronic Controllers supplied with or without set-point. *Request Bulletin A-702.*

AUTRONIC RECORDERS

The Recorder is an accurate plug-in instrument that produces a true linear or square-root trace on a 31-day strip chart. Pen position is measured by a differential transformer which produces an a-c voltage proportional to pen travel. This voltage is compared to the 0.0 to 0.500 a-c voltage from primary element transmitter. Difference between these voltages is amplified and current is sent to a rotary solenoid which produces a large force to drive pen toward a null-balance position. Recorder produces a true linear trace because pen writes on chart at point where it is bent sharply around chart plate which has same radius as pen arm. This design eliminates complex linkages with their inaccuracy caused by lost motion and friction. Supplied with or without set-point. *Request Bulletin A-704.*

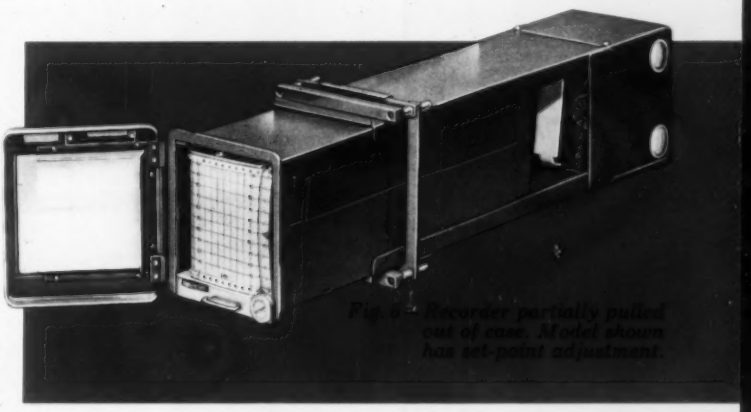


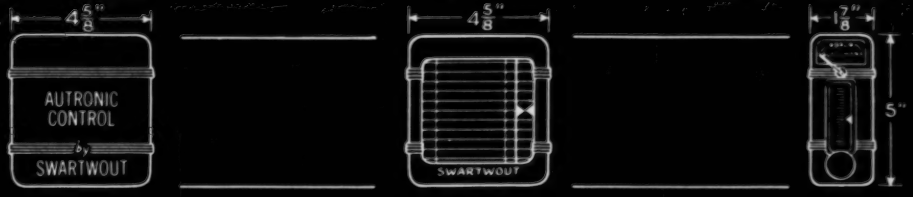
Fig. 6 – Recorder partially pulled out of case. Model shown has set-point adjustment.

AUTRONIC MANUAL CONTROL

The Manual Control is designed for use with other units of the Autronic System or by itself, if desired. Operates independently of Recorder and Controller. By setting Manual Control to "Manual" either Recorder or Controller may be removed from service. Gives continuous indication of valve position. Simplified switchover means bumpless transfer. *Request Bulletin A-705.*

Fig. 6 – Note selector switch and legible edge-reading dial.

DIMENSIONS



Autronic Controller

Autronic Recorder or Indicator

Manual Control

Fig. 7 – Autronic Indicator.

AUTRONIC INDICATOR

The Indicator is a rapid, accurate, miniature plug-in type instrument interchangeable with the Autronic Recorder. Can be supplied either with or without set-point adjustment.

AUTRONIC POWER RELAY

Fig. 8 – P2R Power Relay. Can also be furnished explosion proofed.

P2R Power Relay is an electro-pneumatic transducer operating on the null-balance principle wherein a magnetic force is balanced against the force produced by the air-output pressure from the pneumatic pilot. It takes the d-c control signal and converts it to a proportional air-loading pressure. This makes it possible to utilize the low cost and flexibility of air-operated valves without the normal air system lags. Unit can be used direct- or reverse-acting. 4-8 milliampere d-c control signal corresponds to 3-15 psi output pressure. Other units in ranges of 3-27 and 6-54 psi available. *Request Bulletin A-710-A.*

AUTRONIC TEMPERATURE TRANSMITTERS

Fig. 9 – T2E Resistance Thermometer with standard thermowell and connecting head, and T2A Thermometer Adapter.

Temperature Transmitters consist of two units: a thermometer element made of platinum wire wound on a ceramic core and hermetically sealed in an Inconel tube; thermometer adapter which converts resistance changes of thermometer element to proportional signal voltages of from 0.0 to 0.500 volts 60-cycle a-c for full range of thermometer element. Interchangeable range cards in the adapter permit range spans from limits -50° to 700°F or -50° to 350°C standard, or to special ranges. *Request Bulletin A-706-A.*

THERMOCOUPLE-AIR CONVERTER

Fig. 10 – T3C Thermocouple-Air Converter with interchangeable range cards.

The Thermocouple-Air Converter is used with thermocouples or other low voltage d-c inputs. Since it converts d-c millivolt signals to air-output signals, it enables customers to retain their pneumatic recording and controlling panel components and capitalize on the advantages of the Autronic System. Upper section is an amplifier-converter similar to the T2C Thermocouple Converter *(Bulletin A-712)*; the lower section an electro-pneumatic transducer similar to the P2R Power Relay *(Bulletin A-710-A)*. A high-impedance, null-balance unit which does not draw current from thermocouple, the T3C converts d-c millivolt signals to a 3-15 psi air signal in a linear relationship. Fixed or continuously adjustable interchangeable range cards. Standard ranges from a low of -100° to a high of 3000°F. Transducer section can be explosion proofed. *Request Bulletin A-714.*

AUTRONIC THERMOCOUPLE CONVERTER

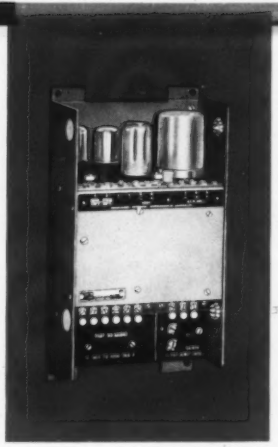


Fig. 11 – T2C Thermocouple Converter with interchangeable range cards.

The Thermocouple Converter is an amplifier-converter unit that enables the Autronic System to be used with thermocouples or other low voltage d-c inputs. A high-impedance, null-balance unit which does not draw current from thermocouple, it converts d-c millivolt input signals to a 0.0 to 0.500 volt a-c signal. No batteries, slide wires or motors. Fixed temperature range cards or continuously adjustable range cards available. Many standard ranges available from a low of -100° to a high of 3000°F. *Request Bulletin A-712.*

PRESSURE TRANSMITTERS

Output of the Pressure Primary Element Transmitters is proportional to pressure being measured. Minute movements of the stainless steel diaphragm are amplified through a friction-free linkage to the movable core of a differential transformer which produces an output signal of from 0.0 to 0.500 volts 60-cycle a-c directly proportional to pressure being measured. Ranges adjustable to 400% zero suppression of span setting. Continuously adjustable spans: 0-40 to 0-200 psi, 0-200 to 0-1000 psi, 0-1000 to 0-5000 psi. *Request Bulletin A-708.*

Fig. 12 – P2T Pressure Primary Element Transmitter.

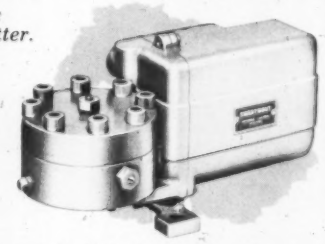
FLUSH DIAPHRAGM PRESSURE TRANSMITTER

Fig. 14 – P3T Flush Diaphragm Pressure Transmitter.

The Flush Diaphragm Transmitter is mounted on the process pipe so that diaphragm is in contact with process fluids. This design eliminates stagnant pressure lines which must be heat jacketed. Particularly valuable for measuring pressures in polymers, asphalts, viscous fluids, molten metals, etc. Transmission lags are eliminated because measurement data is converted to electric signal without motors, boosters, slide wires or vacuum tubes. Movement of diaphragm is amplified through linkage and moves core of differential transformer which produces 60-cycle a-c output of from 0.0 to 0.500 volts directly proportional to measured variable. Continuously adjustable ranges of 0-200 to 0-1000 psig, and 0-1000 to 0-2500 psig. For operation to 300° C standard. Higher temperatures and pressures available on special order. Can be supplied explosion proofed. *Request Bulletin A-713.*

DIFFERENTIAL PRESSURE TRANSMITTER

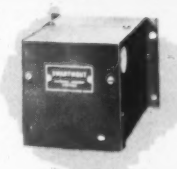
Fig. 13 – D2T Differential Pressure Primary Element Transmitter.



The Differential Pressure Transmitter covers a differential pressure range of 0-20 to 0-1000 inches water and static pressures to 5000 psig. A unique anti-thrust pressure seal transmits motion of sensing diaphragm through friction-free amplifying linkage to movable core of differential transformer which gives 60-cycle a-c output of from 0.0 to 0.500 volts directly proportional to variable. Response is instantaneous because there are no electric motors, slide wires or contacting mechanisms; no air lines to leak, freeze or corrode. *Request Bulletins A-707-A and A-707.1-A.*

AUTRONIC ADAPTER UNITS

Swartwout makes many adapter units to utilize any a-c or d-c signal such as strain gauges, pH, oxygen, etc., for use with Autronic Controllers, Recorders, or other units.

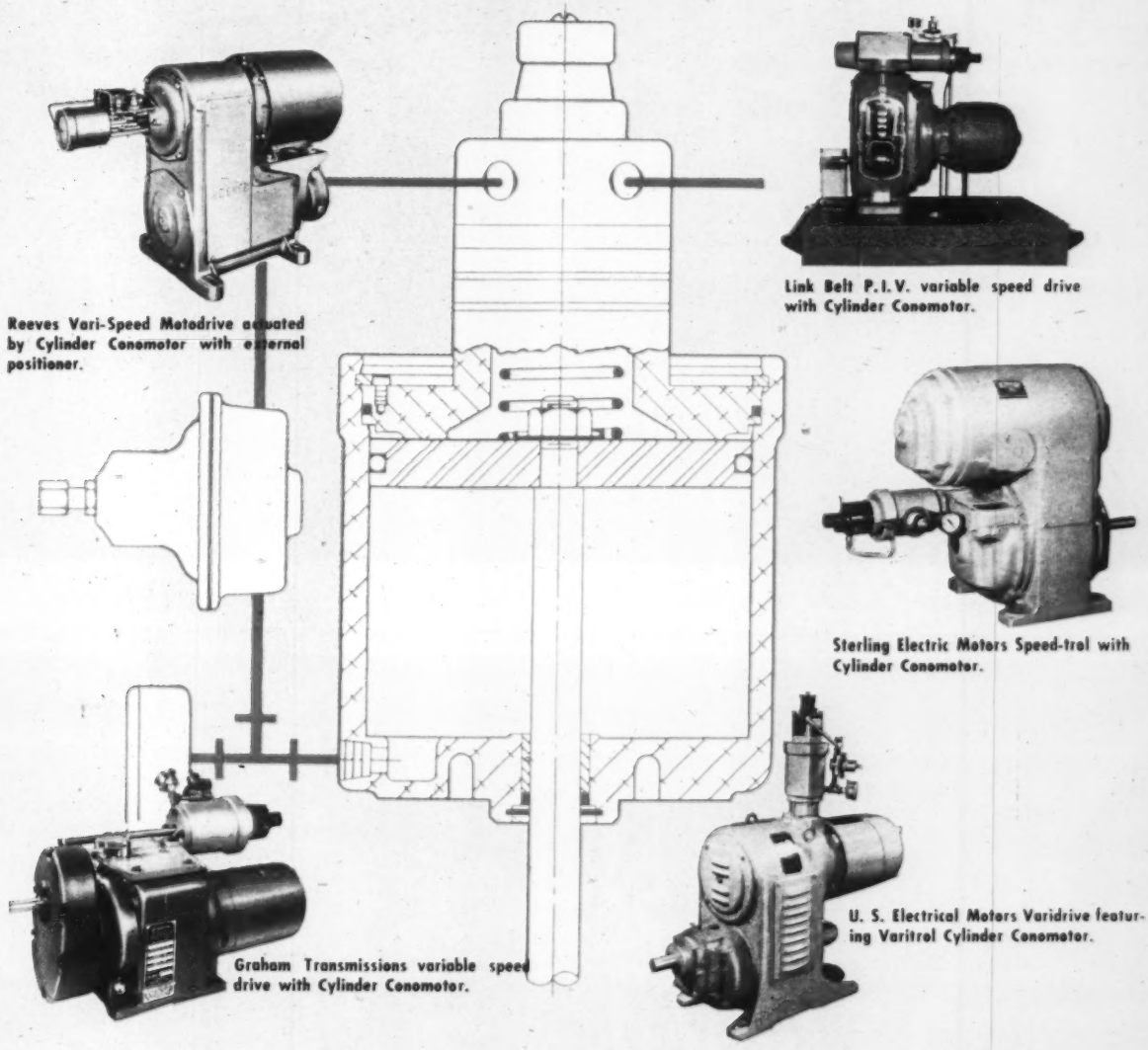


Swartwout *Autronic®* CONTROL SYSTEM

THE SWARTWOUT COMPANY • 18511 EUCLID AVENUE • CLEVELAND 12, OHIO

Litho in USA

LOW COST, EFFICIENT Automatic Speed Control NOW AVAILABLE with the CYLINDER CONOMOTOR



Reeves Vari-Speed Motodrive actuated by Cylinder Conomotor with external positioner.

Link Belt P.I.V. variable speed drive with Cylinder Conomotor.

Sterling Electric Motors Speed-trol with Cylinder Conomotor.

U. S. Electrical Motors Varidrive featuring Varitrol Cylinder Conomotor.

Graham Transmissions variable speed drive with Cylinder Conomotor.

For many years, industry's requirements for a practical method of controlling speed in operations involving such variables as flow, temperature, pressure, liquid level, tension, etc., could not be adequately satisfied. Now, the Cylinder Conomotor—a pneumatically positioned power operator used as original equipment on virtually all major variable speed drive units—affords low cost, dependable automatic speed control for processes ... . roll-winding equipment . . . heat exchangers . . . machine tools . . . material conveyors.

Engineers are becoming more and more conscious of the possibilities offered by automatic control of variable speed drives through pneumatic means. Pneumatic speed control combines all the advantages of simplicity, versatility and sensitivity at a low, low cost. An additional inherent feature of pneumatic control is its explosion-proof characteristic—a specified must in many industries today.

Conoflow engineers, seasoned in control techniques, can help you adapt the Cylinder Conomotor to your speed changing requirements . . . Call in Conoflow today, you'll like our personalized service.

FOR ADDITIONAL INFORMATION ON CONOFLOW CYLINDER OPERATORS WRITE FOR BULLETIN B-50-2

CC 502

Cono-Controls®

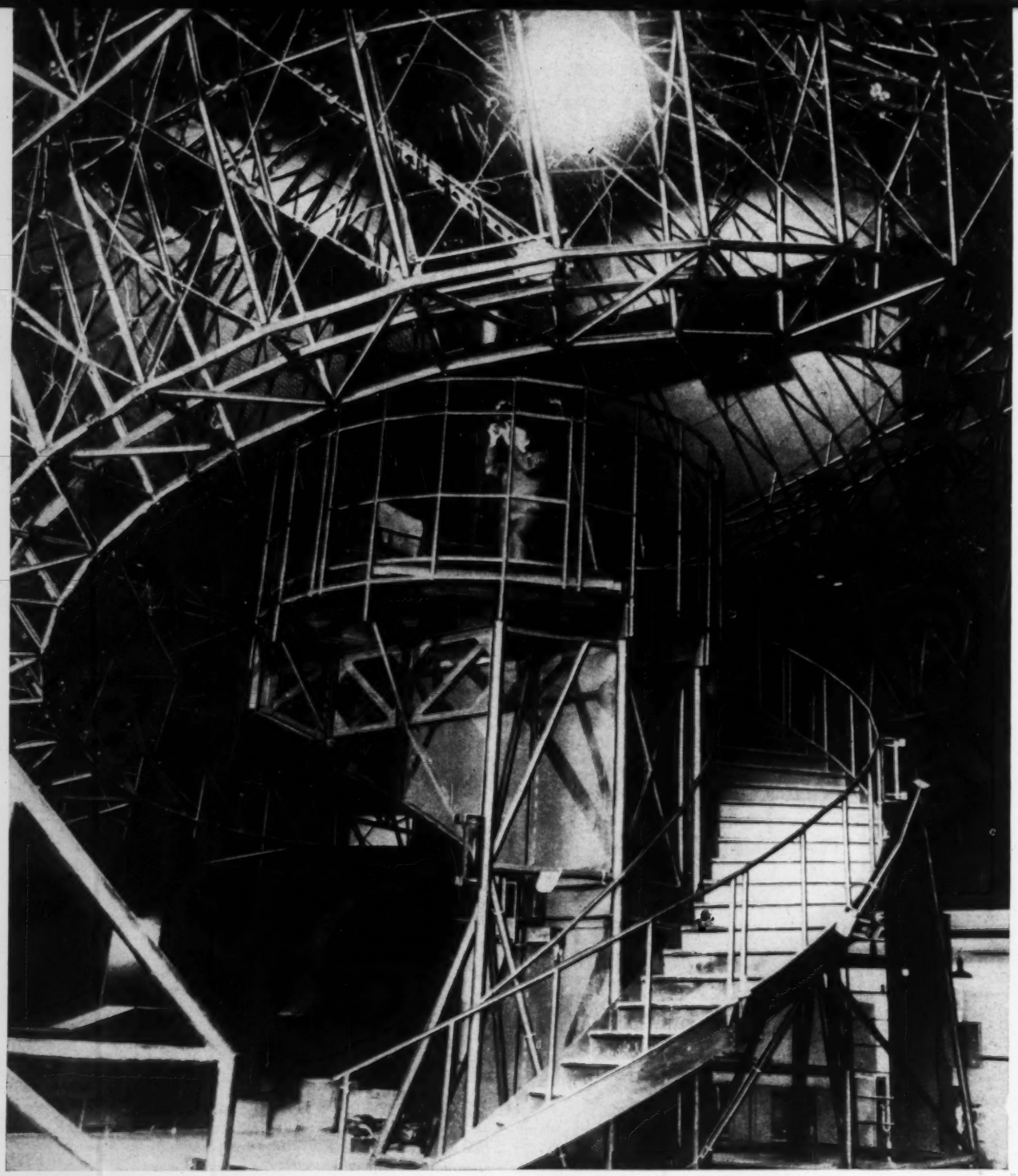
CONOFLOW CORPORATION

FOREMOST MANUFACTURERS OF FINAL CONTROL ELEMENTS

2100 ARCH STREET, PHILADELPHIA 3, PA.

For more information circle **8** on inquiry card.

← Circle **7** on inquiry card.



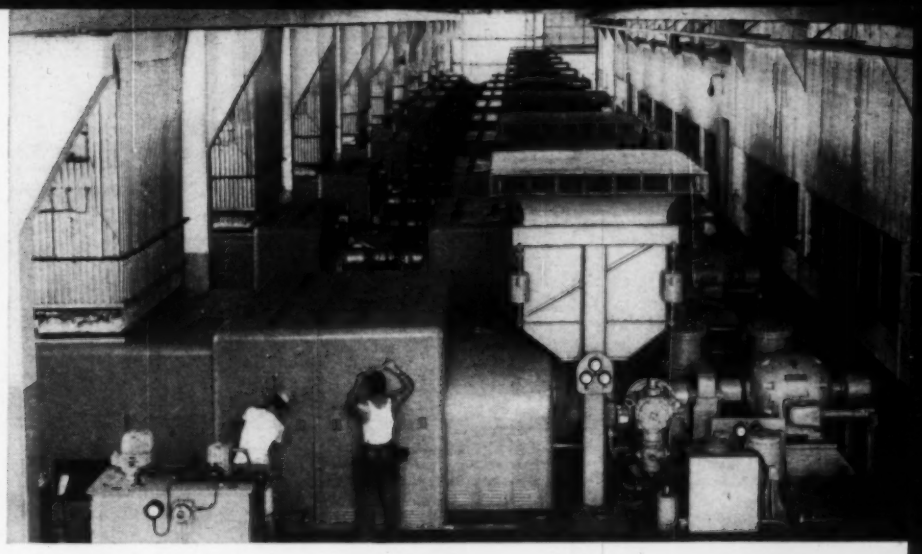
CELESTIAL NAVIGATION—Link Aviation's high-speed, high altitude celestial navigation trainer; only such trainer capable of simulating trans-Polar flight. Trains navigators in techniques of guiding planes by the stars.

Vital Controls

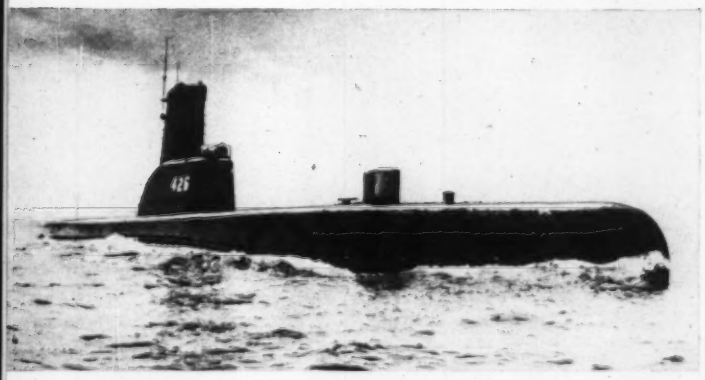
The controls on the world's fastest submarine; the most advanced airborne navigation system known to exist; other similarly advanced military systems and equally advanced industrial equipment and control systems are outstanding examples of the work of the producing companies of General Precision Equipment Corporation. More than a dozen major industries are served by instrumentation and systems designed, developed and produced by GPE Companies.

Ten of the companies in the GPE Group – notably Askania, Kearfott, Librascope and Link Aviation–devote substantial resources to the development and manufacture of instruments, servos and controls. These are used in equipment and systems developed by these companies

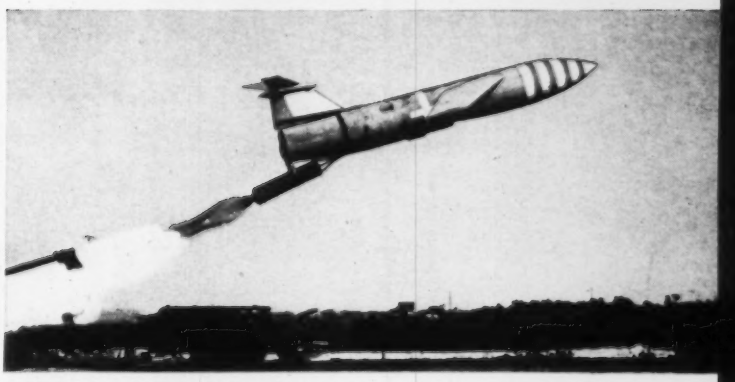
For more information circle 9 on inquiry card.



PROCESS CONTROL—Askania controls regulate speed of the ten turbines which develop compression to maintain gas suction pressure in Creole Petroleum Corporation's giant, pile-supported oil drilling operation on Lake Maracaibo, Venezuela.



SUBMARINE OPERATION – Controls developed and produced by Askania Regulator Company are utilized to govern operation of U. S. Navy's modern Guppy type submarines.



MISSILE GUIDANCE—One of the many guided missiles equipped with Kearfott basic gyro reference systems, the B-61 Matador—U. S. Air Force's first successful ground-to-ground tactical weapon.

GPE

CAPACITIES

● Manufacturing
●● Manufacturing and product development
●●● Manufacturing, product development and research
□●● Pilot manufacturing, product development and research

	KEARFOTT COMPANY, INC.	INTERNATIONAL PRODUCTION CORPORATION	BLUDWORTH MARINE DIVISION	GENERAL PRECISION LABORATORY INCORPORATED	THE GISSCOM-RUSSELL COMPANY	LINK AVIATION, INC.	THE HEPTNER ELECTRIC COMPANY	THE STRONG ELECTRIC CORPORATION	J. E. McAULEY MFG. CO.	ASKANIA REGULATOR COMPANY	AMPRO CORPORATION	LUBRASCOPE, INCORPORATED
PRECISION MECHANICS, OPTICAL DEVICES, CERAMICS	●●●	●●	●●	□●●	●●	●●●	●●	●●●	●●	●●	●●	●●●
ELECTRICAL EQUIPMENT and COMPONENTS	●●●	●	●			●●●	●●●	●●	●	●●	●	●●●
ELECTRONICS	●●●	●●	●●●	●●●		●●●	●	●●		●●●	●●	●●●
HYDRAULICS, LIQUIDS PROCESSING, HEAT EXCHANGE		●●			●●●					●●●		
TELEVISION Studio, Theatre, Educational, Business, Industrial	●	●		●●●		●				●		
INSTRUMENTS, SERVOS, CONTROLS Hydraulic, Pneumatic, Magnetic, Electronic	●●●	●	●●	□●●		●●●	●●	●●		●●●	●	●●●
AIRCRAFT and MISSILE GUIDANCE, CONTROL, SIMULATION	●●●	●		●●●		●●●	●			●●	●	●●●
AUTOMATIC COMPUTERS and COMPONENTS	●●●	●	●	□●●		●●●				●●●		●●●
RADAR, MICROWAVE, ULTRASONICS	●●●	●	●●	●●●		●●		●		●		
MOTION PICTURE and AUDIO EQUIPMENT		●●●		□●●			●●	●●●	●●●		●●●	
NUCLEAR POWER COMPONENTS and CONTROLS	●●●				●●					●●		●●●
SYSTEMS ENGINEERING Aeronautical, Naval, Industrial	●●●			●●●	●●●	●●●				●●●		●●●

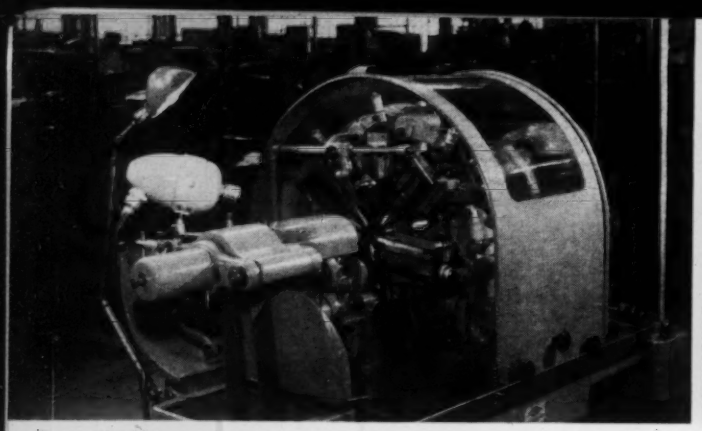
themselves, as well as in systems and equipment developed and produced by other manufacturers of advanced technological equipment.

All GPE Producing Companies work in the advanced areas of highly specialized fields and are engaged in the design, development, manufacture and sale of equipment which is closely related from a technical point of view. It is all precision equipment; it derives from similar fields of technical competence; it saves labor, increases productivity or achieves results which cannot be achieved with even limited use of on-the-spot manpower. The chart here shows the specialized fields in which the key GPE Producing Companies work.

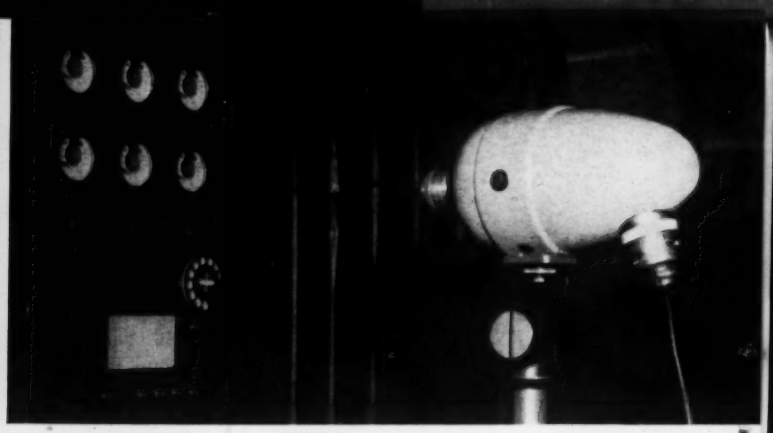
In addition to specialization in its particular products and fields of technical competence, each of these companies has at its command, as required, the facilities and specialized techniques of the other GPE Companies in their respective fields. Interrelation of their resources is achieved through GPE's basic operating policy, GPE Coordinated Precision Technology. In all areas in which GPE Companies work, this coordination has been responsible for a wide variety of precision equipment of superior design and performance, embodying new, advanced principles.

A brochure relative to the work of the GPE Companies and GPE Coordinated Precision Technology is available. Address your request, or specific inquiries, to: GENERAL PRECISION EQUIPMENT CORPORATION – 92 Gold Street, New York 38, N. Y.

For more information circle 9 on inquiry card.



Watching machines is a job for the GPL TV camera. Above, the GPL camera mounted to face a screw-making machine instantly reports anything needing attention to the operator, increasing the number of machines he can tend efficiently.



In automation, whenever there are dials to be checked, the GPL TV camera can report to a central point. Motorized on rails or to swing around, the camera scans a whole bank of dials, sweeps an area. Equally useful in non-automatized production.

Danger is no problem. The GPL industrial TV camera can look into the face of danger and never blink. Above it reports to the operator a hazardous process taking place inside a test cell.

Wherever security control is a problem, strategically placed GPL TV cameras multiply the eyes of your guards. Here a single camera keeps watch over vital military equipment. Similarly, GPL TV cameras can guard the aisles of warehouses, restricted areas, exposed loading platforms.

Control Problems Solved by Seeing

GPL industrial television opens up new possibilities in control by providing instantaneous visual information on what's happening.

Good control is based on good information. And for many purposes no information can match seeing what is happening right on the spot. You can do just this, anywhere, anytime, with the industrial and institutional television equipment designed and made by General Precision Laboratory Incorporated, and known as GPL ii-TV.*

No spot is too far away, too dangerous, too cramped for GPL ii-TV. Unattended, the camera permits observers to see around corners, through walls, across thousands of miles, within the whirling heart of a machine. It can bring many scattered events to a single observer and, with GPL TV projectors, a single event to many scattered audiences.

With this new tool you can solve many kinds of control problems. You can use GPL industrial television to monitor remote machines. You can study a wing tip five miles up, or watch a grapnel grope along the ocean floor. You can follow and control a dangerous process, step by step, safe from fumes or radiation. You can control access to restricted areas, check signatures against a master file.

In fact, you can use GPL industrial television for anything that requires instant communication of visual information. You can improve skills and techniques of workers in scattered plants with visual demonstrations. You can run face-to-face conferences of far-flung personnel.

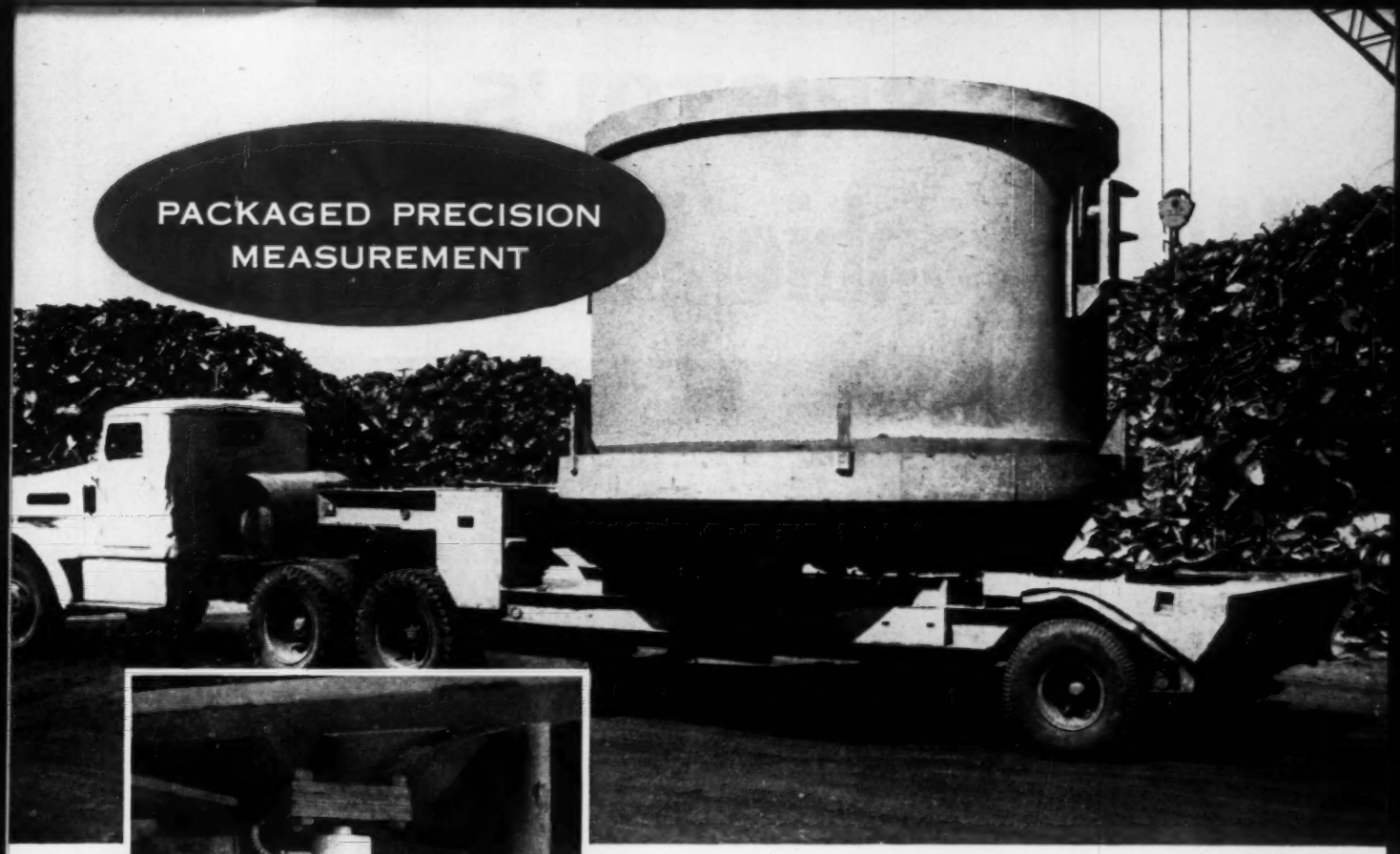
A GPL Industrial and Institutional Television System can do all these things for you—and many others—with high efficiency and low cost. Here's why:

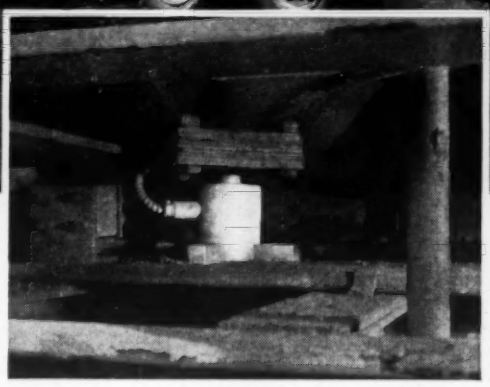
* Trade-mark

- It is high-sensitivity, quality equipment. Behind it lies the long experience of General Precision Laboratory in building the finest in broadcast television. GPL equipment is used by 90 percent of all studios equipped for video recording; GPL cameras and controls are found in many of the finest broadcast TV installations.
- Military TV equipment must be really rugged—and GPL has been building it for years. Now GPL has designed your industrial TV system with high-strength elements and simple design that stand the gaff. Special housings protect the camera from weather, heat, shock, explosions.
- GPL's compact industrial camera is bullet-shaped to squeeze in almost anywhere. Only 2" larger in diameter than a baseball, it weighs 5 lbs. The 26-lb. control cabinet, the size of an overnight case, can be far from the camera.
- GPL's industrial camera is unique in its ability to obtain a good picture at very low light levels. With its Vidicon pick-up tube it can work under highly adverse conditions.
- GPL enables you to multiply your audience with a TV projection system for industrial use. It is made like the famed GPL theatre projectors used all over the country; mounted on rollers for complete mobility.

For more information on what GPL ii-TV can do for you—and suggestions on your special problems—write to: GENERAL PRECISION LABORATORY INCORPORATED, Pleasantville, N. Y. (A subsidiary of General Precision Equipment Corporation.)

For more information circle **10** on inquiry card.





SR-4® Load Cells cut handling time by weighing scrap anywhere in yard

Baldwin's "Packaged Precision Measurement" can help you lower the cost of handling all heavy materials.

That's being demonstrated in this scrap steel yard of a large steel mill. Baldwin's SR-4 Load Cells, installed under loading buckets, have reduced greatly the time required to load the scrap steel and move the buckets on to electric furnaces.

Here's how. Each truck is fitted with four SR-4 Load Cells supporting the scrap hopper (see smaller photo). Continuous, accurate weight is provided by a Baldwin Type 5 Precision Indicator mounted on the trailer in a steel housing, powered by batteries through an inverter.

This system is much more flexible than the previous method. The previous one had wasted a lot of time because it was necessary to move the scrap load to a scale car on tracks that could only move back and forth under an overhead crane.

Thanks to Baldwin's "Packaged Precision Measurement," scrap charge load weights (upwards of 50 tons each now) are checked instantly on the indicator during loading operations *anywhere in the yard.* The exact amount of scrap needed is in the bucket when it leaves the scrap yard.

SR-4 devices are ruggedly built to withstand severe impacts and overloads. Their exceptionally high accuracy does not change with age. There are no moving parts to wear out. There's no hydraulic system to control. For detailed information about SR-4 device applications and instrumentation, write us or use the coupon right away.

BALDWIN · BLH · LIMA-HAMILTON

Eddystone Division

BALDWIN-LIMA-HAMILTON

For more information circle **11** on inquiry card.

Dept. 3415, Baldwin-Lima-Hamilton Corporation
Philadelphia 42, Pa.
(In Canada: Peacock Bros., Ltd., Montreal, Quebec)

Please send me the following new literature:

- ☐ Bulletin 4300 (Introduction to SR-4 Devices)
- ☐ Bulletin 4301 (SR-4 Load Cells and Load Beams)
- ☐ Bulletin 4304 (SR-4 Crane Scales)
- ☐ Bulletin 4302 (SR-4 Weighing of Tanks, Bins, Hoppers)

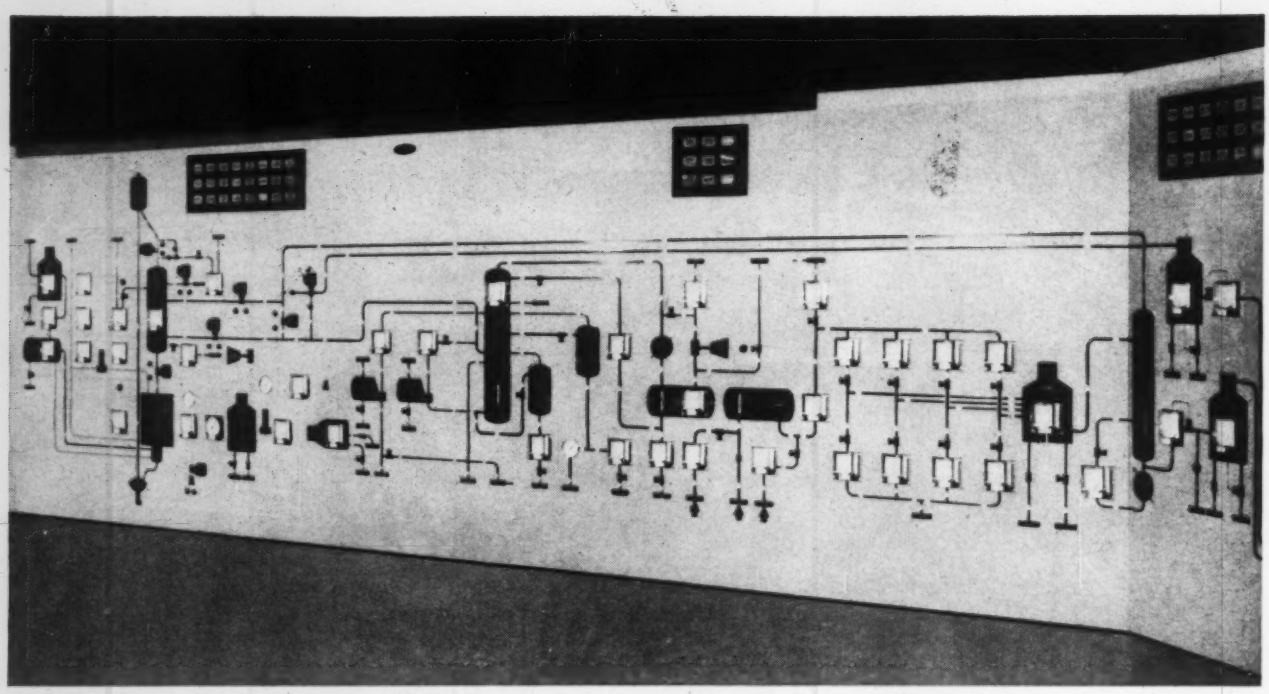
Name _____ Title _____

Company _____

Address _____

City _____ Zone _____ State _____

BRISTOL'S
Metagraphic Receiver line



THIS TYPICAL GRAPHIC PANEL OF BRISTOL METAGRAPHIC INSTRUMENTS IN AN OIL REFINERY FEATURES:

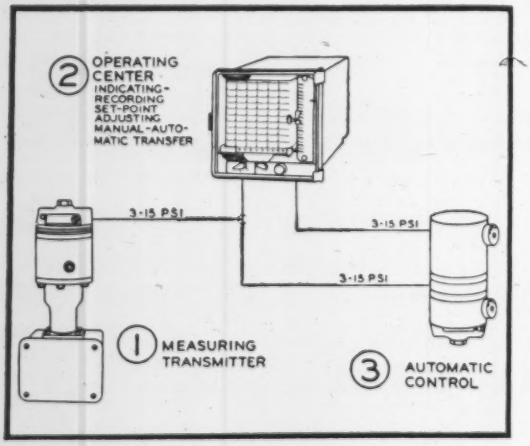
Human engineered, scientifically designed scales for error-free close-by, as well as distant, readability.

Molded clear plastic doors improve visibility to the limit – no shadows or reflections.

All measurements are on the same scale plate.

The instrument presents readings to the process operator in the most easily grasped form. High-visibility, colored fluorescent paints are used on pointers to enable operators to easily tell them apart. All pointers for a given function are the same color in all instruments.

A new degree of performance, flexibility, and ease of servicing in a pneumatic receiver



HOW THE METAGRAPHIC RECEIVER HOOKS INTO CONTROL SYSTEM. Note that Metagraphic Receiver is *outside* the control loop. As a result, unplugging the receiver creates no transient disturbance in the control loop.

FULL PLUG-IN SERVICE: The chassis of a Metagraphic receiver is built for full plug-in service. It is of one-piece construction and can be withdrawn to an intermediate position for servicing, without interrupting its operation, or completely removed from the case (no tools required).

Flexibility. Full plug-in construction provides a flexibility of use that can't be matched. A recorder can be changed to an indicator or vice versa in less than 10 seconds by merely replacing chassis. One model can be changed to another or, if trouble is suspected, the doubtful unit can be replaced by a spare.

No interruption whatever to automatic control when receiver chassis is removed. The set point and manual-automatic transfer station are part of the receiver case. With the chassis removed from the case the controller functions as a blind controller. You get the same automatic control with chassis removed.

When a recorder chassis is replaced the chart can be easily removed and put on the new chassis.

Ease of servicing. Little or no maintenance is required. Simplicity of construction and plug-in feature make it possible, if trouble is suspected, to check receivers while they are still in operation by pulling chassis out to the intermediate position

For more information circle **12** on inquiry card.

gives you 35 models to choose from

where it can be inspected, charts changed, pens inked, zero adjusted, and clocks serviced. A receiver suspected of giving trouble can be replaced in a few seconds with a stand-by unit and checked and serviced in the service shop – out of service time is thus eliminated.

Anybody can learn to check and service a Metagraphic Instrument in a few minutes.

CONTINUOUS VALVE POSITION INDICATION on same instrument scale plate as set point scale gives continuous data on control valve position – makes "bumpless" transfer possible, simply by matching pointer positions – no need to read actual scale values – minimizes reading errors – speeds operations.

IDEAL FOR GRAPHIC PANEL AND CONSOLE USE: More instruments can be mounted in a given panel area than with any other type of receiver.

They fit into a 4-9/16" square cut out – no notches required.

They mount 6-1/2" center to center on panel (6-1/2" and 7" with controller plugged into receiver case).

SCALES ARE SCIENTIFICALLY DESIGNED for instant, error-free readability – a new degree of close-up, as well as distant, readability. Control information can be obtained at a glance at distances up to 20 feet by noting whether pointers match – no need to read scales.

OFFERED FOR UP TO 3 MEASURED VARIABLES – With air pressure regulators or air-loaded regulators, three-position manual-automatic transfer valves for automatic control, and six-position (on same knob) transfer valves for cascade control.

ALL MEASURING ELEMENTS in receiver are the same high quality and accuracy. They all indicate on the same scale plate.

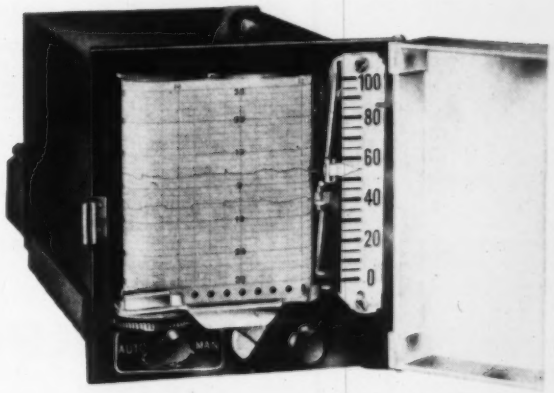
AIR CHART DRIVES are 100% pneumatic operated – no electricity is needed in control room for clock – operates off 20 psi air supply.

UNIVERSAL PIPING MANIFOLD can be adapted to any piping (2-pipe or 4-pipe system). Only a screw driver and wrench needed – no parts required.

HIGH-VISIBILITY COLORED FLUORESCENT PAINTS are used on pointers so operators can easily tell them apart. Pointers for a given function are the same color in all instruments. Control information can be obtained at a glance at distances up to 20 feet by noting whether pointers match or have deviated from each other – no need to read scales.

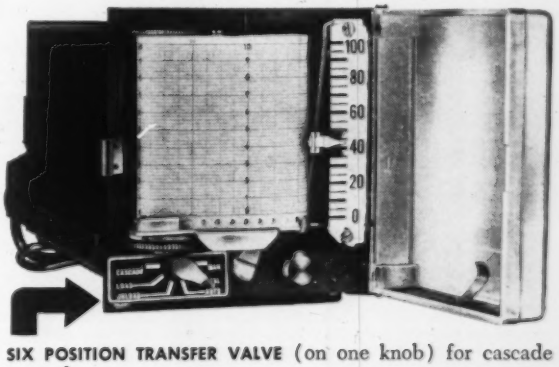
Write for the Bristol Metagraphic Receiver bulletin. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn. 5.31

TWO-PEN RECORDING RECEIVER



THIS METAGRAPHIC TWO-PEN RECORDING RECEIVER, with Manual-Automatic Station records, indicates, and controls one measured variable, records one related variable on the same chart, and gives a continuous indication of either set-point or valve-position whichever is desired. If valve position is chosen to be continuously indicated, set-point may be indicated by depressing the valve knob or vice versa. The two recorded variables are at *no time* disturbed.

SIX-POSITION TRANSFER VALVE



SIX POSITION TRANSFER VALVE (on one knob) for cascade control.

Metagraphic instruments measure, record, indicate and automatically control:

Pressure	Liquid Level
Vacuum	Flow
Absolute Pressure	Temperature and
Differential Pressure	Mechanical Motion

VISIT US AT BOOTHS B399 – B403, ISA SHOW, LOS ANGELES.

BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **12** on inquiry card.

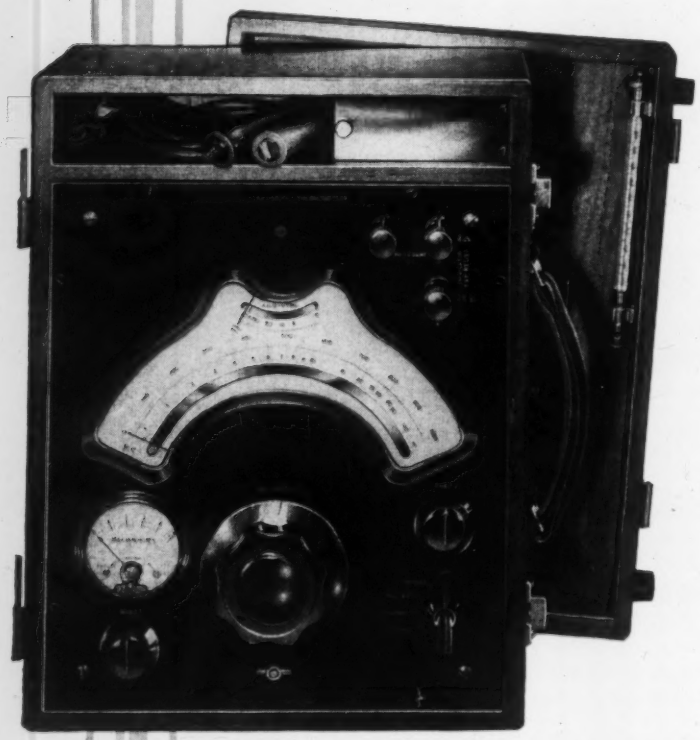
AN ACCURATE, PORTABLE, MULTI-FUNCTION INSTRUMENT

THE LEWIS *PORTABLE* TEST POTENTIOMETER

for Service Testing Exhaust Temperature Measuring Systems

Developed for use by field service engineers of a leading engine manufacturer, the Model 13P05 Test Potentiometer has proven its serviceability in desert heat and arctic cold at maintenance bases on many points of the globe.

FOUR PRECISION INSTRUMENTS IN ONE!



Model 13P05

For dependable maintenance, use test equipment made by the manufacturer of the components to be checked.

A PYROMETER-POTENTIOMETER

for measuring exhaust thermocouple temperatures that is truly portable with a sturdy pivoted galvanometer and without a standard cell. Accurate automatic electrically operated cold junction compensation permits this instrument to be used in ambient temperatures from below freezing to plus 120°F. Mirror scales with precise hand-drawn graduations and knife edge pointers insure accurate readings from zero to 1000 degrees Centigrade.

A LOW RANGE OHM-METER

with a widely spaced, hand drawn scale for checking the resistance of leads, thermocouples and balancing resistors to insure correct adjustment to match external resistance requirements of exhaust temperature indicators, either eight or twenty-two ohms.

A KILO-OHM METER,

energized by a 67½ volt battery for checking insulation resistance of lead-wires and thermocouples. Due to the potential applied, this circuit is more effective in detecting flaws than conventional ohm meters. A hand-drawn scale is clearly marked in kilo ohms resistance.

A THERMOMETER TESTER

for precise scale error checks of exhaust temperature indicators having either eight or twenty-two ohms external resistance. A controlled power supply energizes the indicator under test, through the correct series resistance, and the zero to 1000°C temperature scale is used as a reference standard. Recommended for use in adjusting exhaust indicators in accordance with ambient temperature, with power applied for 700°C, through the proper resistance. A liquid-in-glass thermometer and flexible test leads are supplied with each instrument.

LEWIS ENGINEERING CO.

NAUGATUCK, CONNECTICUT

For more information circle **13** on inquiry card.

Trends...

INSTRUMENTS and AUTOMATION

Regional areas are enticing expanding instrument manufacturers; Fort Worth, Texas, Chamber of Commerce announces $10 million industrial park site suited to needs of instrumentation industry.

Mobile radio services authorized by FCC (industrial, safety, and transportation) exceed 430,000, over half of which are on the air. Industrial use is expanding in power, petroleum, forest products, etc.

Number of radar-equipped vessels in passenger and merchant service exceeds 7000. Over 50% of marine radars in the world are of British manufacture.

Magnetic recording is expanding field. Use is expanding in control and analysis of noise, vibration, acoustics; flight testing; geophysical exploration; digital data processing.

Trend to industrial use of data reduction equipment is outstanding. New 20,000-bpd Canadian Petrofina Refinery in Montreal will have $50,000 Fischer & Porter Logger to monitor and record 480 process variables in 9 production units.

Use of mathematicians by industry is increasing—because of increased emphasis on computers, operations research, (including linear programming), statistical analysis (as in quality control), and—a new field just emerging—mathematical research.

Number of men receiving doctorates in science and engineering has doubled from 1948 to 1954—but rate has leveled off since 1950. Number reported by Journal of American Society of Engineering Education:

	1948	1950	1951	1954
Chemistry	630	1098	1101	1169
Physics	245	415	503	548
Mathematics	126	160	204	233
Metallurgy	21	46	73	66
	1042	1719	1881	2016
Chem. Eng.	85	178	159	
Civil Eng.	53	32	43	
Elec. Eng.	36	85	121	
Mech. Eng.	18	48	68	
	1234	2062	2292	

Note that about 70% of all doctorates are in chemistry and physics; less than 20% in engineering courses.

Test centers for engine testing are growing in number and size. New $41 million turbine test center now being completed in West Trenton, N. J. for Navy requires more electrical power than is used by city of 75,000. Control system was designed by M-H.

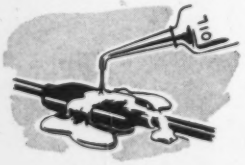
Partners in Production

Joy Electrical Connectors and Automatic Controls

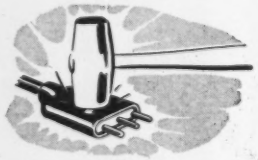
What happens to Automation . . . when electrical connectors fail?

No automatic control system yet devised will keep machines running when an electrical plug or receptacle in their power feeder line or power control circuit *poops out.* That's why JOY's one-piece molded Neoprene connectors deserve your careful consideration. Factory wired and permanently molded to cord or cable, they provide many extra advantages that add up to a long life of dependable service under the most adverse operating conditions. (A few are listed below.) Available in a wide variety of designs with 1 through 16 contacts for 150 to 600 volt applications. **Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.** In Canada: *Joy Manufacturing Co. (Canada) Limited, Galt, Ontario.*

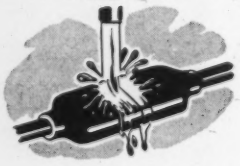
Oil-Sealed . . .
One-piece molded cable connector assembly protects conductors from oil and other external impurities. Face rings protect contacts from similar contamination, when connectors are engaged.



Distortion-Proof . . .
Factory molded as trim one-piece synthetic rubber jacketed units, JOY connectors cannot crack, will not shatter and are practically impossible to knock out of shape.



Moisture-Tight
JOY electrical connectors are absolutely moisture-tight from wiring juncture to face . . . and when connected even their contacts are protectively encased in a resilient housing.



Free . . .
New Bulletin — Ask for No. B59

CD 355.2

JOY

SOURCE OF INDUSTRY'S FAVORITE ELECTRICAL CONNECTORS SINCE '28

For more information circle **14** on inquiry card.

Stock Report . . . .

INSTRUMENTS and AUTOMATION

The following prices and price ranges are supplied by Bache & Co., 36 Wall Street, New York 5, New York

New York Stock Exchange:

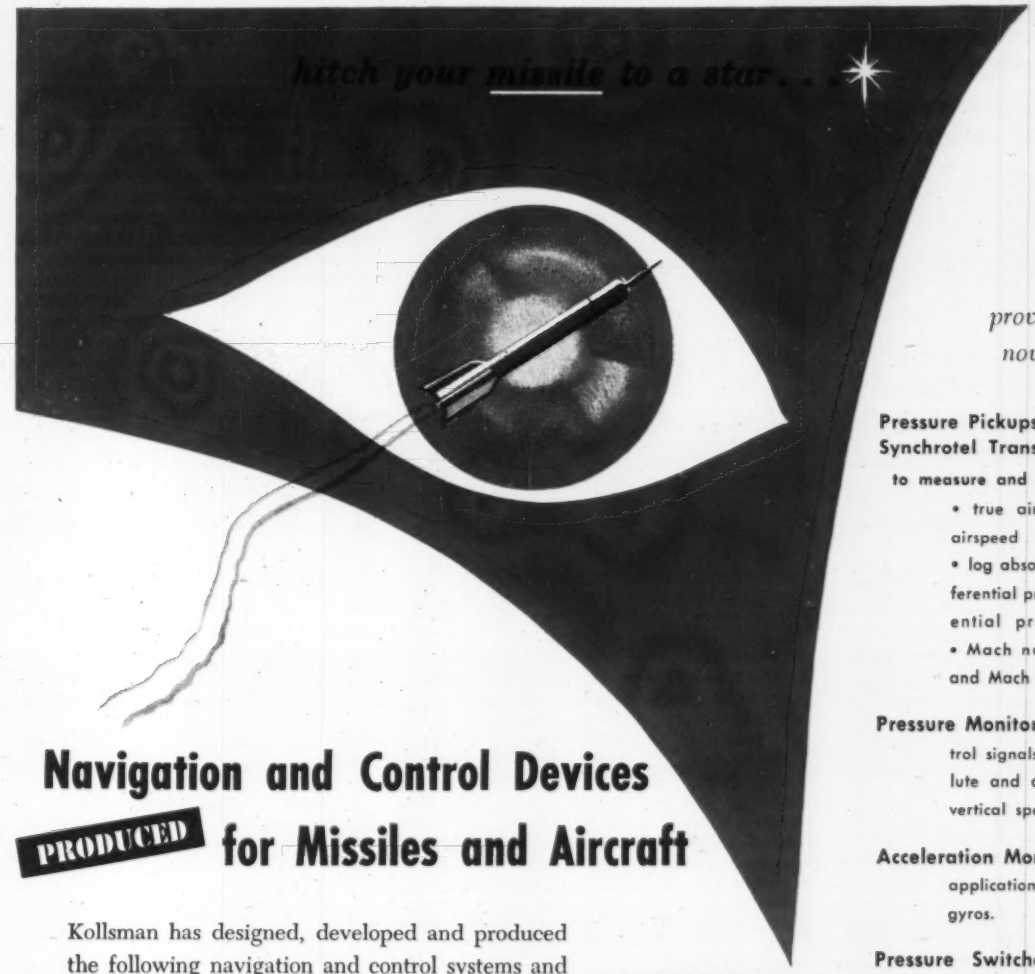
Security	Price Range for Year Thru June 30 High	Low	As of June 30 Last
American C. & C.	41 1/2	35 1/2	40 1/2
American Mach. & F.	35 7/8	25	30 1/4
American Mach. & M.	41 3/8	27 1/2	37 1/2
American Optical	53 1/4	39 1/8	46 3/4
Bell & Howell	42 1/4	30 1/2	40 3/4
Bendix Aviation	59 1/2	48	52 1/4
Bulova Watch	64 3/4	50 3/4	64 1/2
Burroughs	34 1/4	22 7/8	33
Clevite	25 3/8	20 3/4	22 1/8
Dobeckmun	37 3/4	30 1/4	35 5/8
Gamewell	39	31 1/2	34
General Inst.	13	10	10 1/2
General Prec.	71 1/2	44 5/8	52 1/4
General Time	39 3/4	35	37 1/2
Hamilton Watch	25 1/4	20	20 1/2
Int. Bus. Mach.	450	349	415
Minneapolis-Hon.	70	53	63
National Cash Reg.	47	37	40 3/4
Radio Corp.	55 3/8	36 3/4	51 7/8
Raytheon	25 3/4	18	22 1/2
Rem. Rand	58 7/8	31 1/4	57 1/4
Robertshaw-F.	33 5/8	28	31 1/4
Sangamo Electric	30 3/8	26	27 1/2
Sperry Corp. (1)	95 3/4	39 3/4	93 1/2
Square D	52	43 1/2	46 1/4
L. S. Starrett	50	40 3/4	44
Sylvania Elec.	49 7/8	41	48 1/4
Telautograph	37 1/2	25 1/2	33 3/4
Texas Inst.	16 7/8	12 5/8	13 7/8
Underwood	43 1/8	33	42 3/8

(1) Stock to be split.

American Stock Exchange:

Security	Range for 1955 High	Low	As of June 30 Last
Aeroquip Corp.	17 1/2	8 1/2	14 3/4
Air Assoc.	12 3/4	10 1/8	11 1/8
American Meter	37 1/2	32 5/8	37
Beckman Inst.	26 7/8	19 3/8	22 1/4
Benrus Watch	10 7/8	9 5/8	9 3/4
Breeze Corp.	8 7/8	5 3/4	8 1/8
Consolidated Eng.	31 1/4	24	26
DuMont Labs.	17 1/8	13 1/4	15 1/8
ElectroData	17 7/8	12	13 7/8
Fairchild C. & I.	37 1/4	25	26 3/8
Int'l Resistance	9 3/8	5	9 1/4
Lear Inc.	13 3/8	8 3/4	8 7/8
Nat'l Res. Corp.	33 1/4	25 1/4	25 5/8
Neptune Meter	28 1/8	21	27 1/2
New Haven Clock	4 1/8	2 1/2	3
Norden-Ketay	19 1/2	13 1/4	14 7/8
Pneumatic Scale	31	27 1/2	31 - 32 (2)
Servomechanisms	13 3/8	8 1/4	9 1/2
Wallace & Tiernan	26 7/8	22	22
Waltham Watch	2 7/8	1 3/8	1 7/8

(2) Bid - Ask price, no sale.



Navigation and Control Devices PRODUCED for Missiles and Aircraft

Kollsman has designed, developed and produced the following navigation and control systems and components:

FOR NAVIGATION OR GUIDANCE

CLASSIFIED **Photoelectric Sextants** for remote semi-automatic celestial navigation.

CLASSIFIED **Automatic Astrocompasses** for precise automatic celestial directional reference and navigation.

Photoelectric Tracking Systems For many years Kollsman has specialized in high precision tracking systems.

Periscopic Sextants for manual celestial observations.

CLASSIFIED **Computing Systems** to provide precise data for automatic navigation and guidance, operated by optical, electromechanical, and pressure sensing components.

FOR CONTROL

proven components now in production

Pressure Pickups and Synchrotel Transmitters
to measure and electrically transmit • true airspeed • indicated airspeed • absolute pressure • log absolute pressure • differential pressure • log differential pressure • altitude • Mach number • airspeed and Mach number.

Pressure Monitors — to provide control signals for altitude, absolute and differential pressure, vertical speed, etc.

Acceleration Monitors — for many applications now served by gyros.

Pressure Switches — actuated by static pressure, differential pressure, rate of change of static pressure, rate of climb or descent, etc.

Motors — miniature, special purpose, including new designs with integral gear heads.

SPECIAL TEST EQUIPMENT
optical and electromechanical for flight test observations.

Please write us concerning your specific requirements in the field of missile or aircraft control and guidance. Technical bulletins are available on most of the devices mentioned.

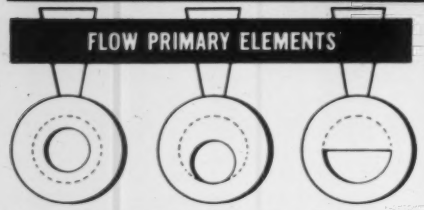
kollsman INSTRUMENT CORPORATION

80-22 45th AVE., ELMHURST, NEW YORK • GLENDALE, CALIFORNIA • SUBSIDIARY OF Standard COIL PRODUCTS CO. INC.

For more information circle 15 on inquiry card.

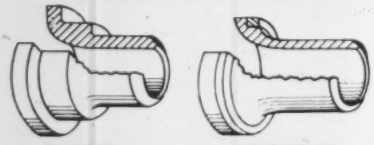
PENN Instruments

FLOW PRIMARY ELEMENTS

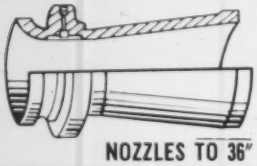


ORIFICE PLATES TO 72″

ORIFICE PIPE ASSEMBLIES TO 4″

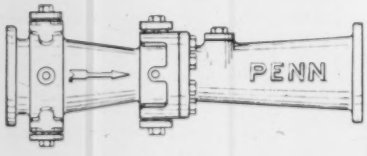


FLANGED WELDING IN



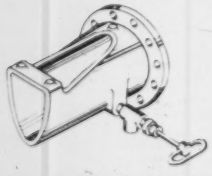
INSERT VENTURI NOZZLE

NOZZLES TO 36″



FOR CLEAN LIQUIDS, SEWAGE AND SLUDGE

VENTURI TUBES TO 72″



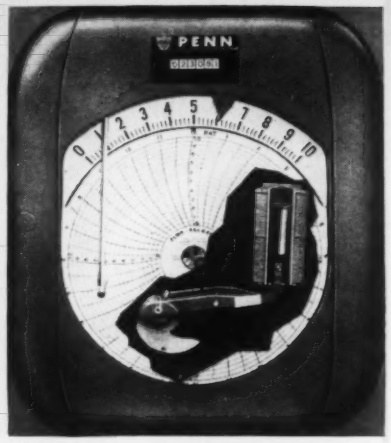
OPEN FLOW NOZZLES TO 36″

LOW HEAD-LOSS FLOW TUBES

All Above Illustrated Primary Elements are MADE BY PENN

PENN MATCHED METERING

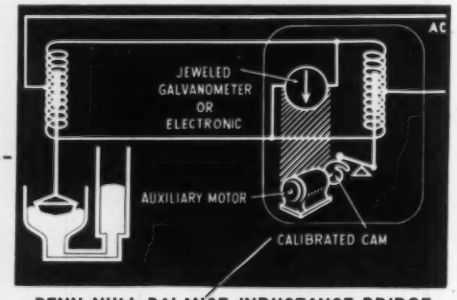
Individually calibrated primary elements can be exactly matched to meter. Penn's high servo-power permits use of large cam which is readily contoured to match special calibration curves or non-standard differentials.



Most Accurate of All Systems

Penn electric metering is based on the ideal null balance inductance bridge. AC power source is necessary only at the receiver. The sensing device is relieved of all work except to position a light core. At the receiver a powerful electric motor moves the core to balance the bridge and simultaneously moves pen, large indicator, totalizer, or potentiometer for re-transmission, summation, or control action. Note particularly the cam which extracts the square root and permits special matching of recorder to calibrated primary elements. Reproducible accuracy ¼%.

Recorder may be thousands of feet from water-proof, explosion-proof transmitter. Transmitter may be indicating type using magnetic coupling to avoid a stuffing box.



PENN NULL BALANCE INDUCTANCE BRIDGE

WITH ELECTRIC RE-TRANSMISSION

Potentiometer in first meter acts as transmitter to operate second remote meter which may be recording or 270° indicating, as illustrated. If first meter is electronic type, as many as 3 potentiometers can be operated for re-transmission or as control devices.

WITH PNEUMATIC RE-TRANSMISSION

Any Penn electric meter can be provided with a Penn pneumatic transmitter to produce 3-15 PSIG signal (linear with flow) to operate other panel size or miniature instruments or proportioning pumps.

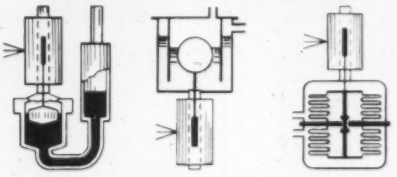
ELECTRIC FLOW METERS

Differential Pressure Type
Area (Linameter) Type

Famous null balance, inductance bridge meters described in left-hand column. 12″ uniform chart, 10″ indicating scale, jumbo fountain pen are standard features. Electronic or galvanometer type receiver.

Only Penn offers both differential pressure and area types to cover this wide range of measurement.

DIFFERENTIAL PRESSURE TYPE



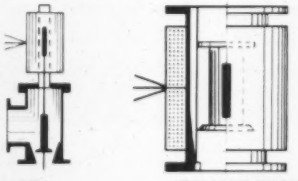
FLOAT IN HG FLOAT IN LDS BELLOWS

A—Float in Mercury
Diff.: 0-15″ to 0 to 1200″
Static: up to 5000 PSIG

B—Float in Low Density Seal
Diff.: 0-2″ to 0 to 10″
Static: up to 75 PSIG

C—Bellows (Rupture-proof, Mercury less)
Diff.: 0-20″ to 0 to 200″
Static: up to 4500 PSIG

AREA (LINAMETER) TYPE



TEE STRAIGHT-THRU

Variable area meter operates on rotameter principle with sharp-edged metering disc moving vertically in tapered throat. Particularly recommended for corrosive fluids, pulps and slurries, viscous liquids, fuel oil and tars, small flows, or where straight pipe run is limited.

Tee Body Transmitters
2″ size: 0-2 to 0-25 GPM
10″ size: 0-390 to 0-1900 GPM
also 3″, 4″, 6″, and 8″ sizes.

Straight-Thru Transmitters
¾″ Size: 0-1 to 0-2 GPM
2″ Size: 0-4 to 0-25 GPM
4″ Size: 0-50 to 0-250 GPM

MECHANICAL FLOW METERS

Differential Pressure Type
Area (Linameter) Type

Recorder, Recorder-Totalizer, Recorder-Controller, Pneumatic Transmitter with linear signal. Penn Magna-Clutch eliminates stuffing box with its leaking, binding, maintenance by providing magnetic coupling which cannot be "unlocked" under most severe service conditions.

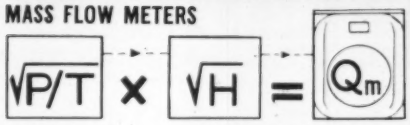
Differential Pressure Type. Ranges 0-20″ to 0-800″ with interchangeable range tubes covering any differential from 50 to 800 inches. Static pressure to 3500 PSIG.

Area (Linameter) Type. Tee bodies from 2″ to 8″. Capacities from 0-4 to 0-1200 GPM.

For more information circle 16 on inquiry card.

METERS FOR SPECIFIC USES

MASS FLOW METERS

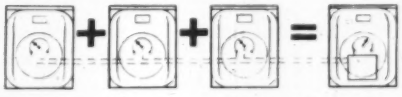


For gas, air, steam measurement. Provide automatic compensation for density changes as determined by temperature and pressure measurement. Wide span of variations can be handled in mathematically rigorous fashion by servo-powered computer mechanisms. In successful use on hydrogen, oxygen, natural gas, wind tunnel air, engine exhaust gases, reheat steam.

COMPENSATED METERS for feed water and boiler drum level employ similar design.

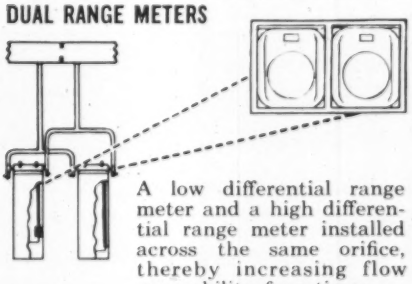
BOILER METERS. Steam flow meter with air flow pen (and additional temperature and pressure pens) for combustion efficiency guide. Many hundreds in use.

SUMMATION METERS



Any number of meters may each be provided with a potentiometer so that meter readings can be added together, recorded, and totalized on a summation meter.

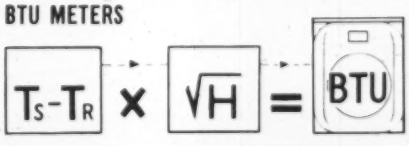
DUAL RANGE METERS



A low differential range meter and a high differential range meter installed across the same orifice, thereby increasing flow rangeability four times.

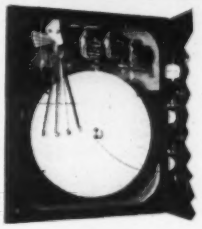
WIDE RANGE METERS. A single meter with 25 to 1 rangeability, accomplished by shaping low range portion of range tube.

BTU METERS



In hot water heating or chilled water cooling, the net BTU is determined by this meter. Temperature difference between "supply" and "return" water is measured by resistance thermometers and continuously multiplied by rate of flow in pounds of water. Servo-powered computer mechanism assures accuracy.

TEMPERATURE-PRESSURE

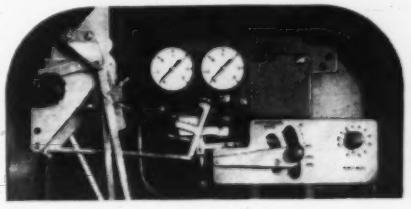


12" Recorders, 1 to 4 pens. Electric, spring, or air clocks. Electric contacts. Also portable type with handle and base.

Temperature: Resistance thermometers, gas-filled, mercury-actuated or vapor tension.

Pressure: Metallic diaphragms, slack diaphragms, bellows, spiral springs, manometers, absolute pressure bellows.

12" AIR-OPERATED RECORDER-CONTROLLER



Exceptionally rugged design. Large bellows with internal spring. Air passages built into "worm" plate for easy cleaning. Jeweled orifices cleanable during operation. All modes: on-off; throttling; throttling with reset and/or derivative; inverse derivative. Furnished with:

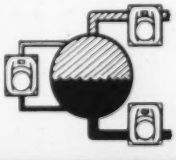
PNEUMATIC SET POINT
MANUAL-AUTOMATIC TRANSFER PANEL
RATIO CONTROL SET POINT
PNEUMATIC RATIO ADJUSTMENT

PNEUMATIC INDICATING TRANSMITTERS

Units suitable for outdoor unprotected location. Wall, panel, or pipe stand. Distances up to 1000 ft. Air output signal 3-15 PSIG, with other ranges available.

For Temperature: Combines Penn pneumatic transmitter with high accuracy 8" dial thermometer. Ranges from −40° to 1000° F. Mercury filled, uniform scale.

For Pressure: Combines Penn pneumatic transmitter with AA quality 6" or 8½" gauge. Ranges from vacuum to 10,000 PSIG and in special construction to 100,000 PSIG.

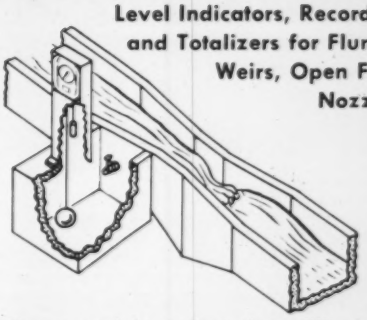


BOILER DRUM LEVEL CONTROL

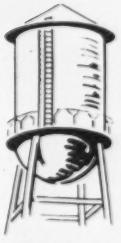
2-element or 3-element air-operated control of valve or hydraulic coupling.

LIQUID LEVEL—POSITION

Level Indicators, Recorders, and Totalizers for Flumes, Weirs, Open Flow Nozzles.



Large stainless float in stilling well operates recorder and totalizer in mechanical type through large cam specially shaped to produce uniform flow chart. Electrical or pneumatic transmission types may have indicating or blind transmission and may transmit thousands of feet to 12" recorder and/or 18" or 36" illuminated indicator.



LEVEL RECORDERS

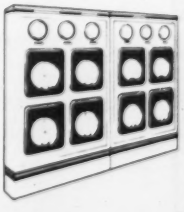
12" chart recorders, controllers, and indicators actuated by static pressure, differential pressure, or float elements and transmitters. Bubbler systems, pressure domes, pump controls, elevated tanks with zero suppression are standard installations.

BOILER DRUM LEVEL RECORDER with or without density compensation.

POSITION TRANSMITTERS. Pneumatic and electrical for valves, gates, dampers.

LONG LINE TELEMETERING

Penn telephone line transmission system utilizing frequency modulated signals in the audible range can be transmitted over telephone company lines including switchboard and dial equipment.



PANELS WIRED AND PIPED

can be furnished complete for connecting up to service lines at installation. Completeinstrumentation or control systems handled with single responsibility.

Over 45 Years of Experience

PENN *Instruments*

DIVISION OF BURGESS-MANNING COMPANY

4100 Haverford Avenue • Philadelphia 4, Pennsylvania

Over 10,000 Installations

For more information circle **16** on inquiry card.

Waterman POCKETSCOPE

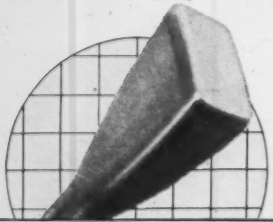
The Pocket-Size Oscilloscope

...light...compact...accurate...portable

Featuring small size, light weight and outstanding performance the HIGH, WIDE and TWIN POCKETSCOPES have become the "triple threat" of the oscilloscope field. Their incomparable versatility, reliability and accuracy have skyrocketed this team of truly portable instruments into unparalleled demand. Each oscilloscope features DC coupled amplifiers in both vertical and horizontal channels.

HIGH

The S-14-A HI-GAIN POCKETSCOPE provides the optimum in oscilloscope flexibility for analysis of low-level electrical impulses. Extremely light weight (12¾ lbs.), compact in size (12 x 5¾ x 7 in.), dependable and accurate in performance. Vertical and horizontal channels: 10mv rms/inch with response within 2DB from DC to 200 KC and pulse rise of 1.8 μs . . . non-frequency discriminating attenuators and gain controls with internal calibration of trace amplitude . . . repetitive or trigger time base with linearization from ½ cycle to 50 KC with ± sync or trigger.



WIDE

The S-14-B WIDE BAND POCKETSCOPE is ideal for investigations of transient signals, DC signals, aperiodic pulses or recurrent waveforms. Vertical channel: 50 mv rms/in. within —2DB from DC to 700 KC . . . pulse rise time of 0.35 μs. Horizontal channel: 0.15v rms/in. within —2DB from DC to 200 KC . . . pulse rise of 1.8 μs. Attenuators and gain controls are non-frequency discriminating . . . trace amplitude calibration . . . repetitive or triggered time base from ½ cycle to 50 KC . . . ± sync or trigger . . . trace expansion, filter graph screen and many other features . . . 14 lbs. . . . 12 x 6 x 7 inches.

TWIN

The S-15-A POCKETSCOPE is a portable, twin tube, high sensitivity oscilloscope with two independent vertical as well as horizontal channels. It is indispensable for investigation of electronic circuits in industry, school and laboratory. Vertical channels 10 mv rms/in. with response within—2DB from DC to 200 KC and pulse rise time of 1.8 μs . . . horizontal channels 1v rms/in. within —2DB from DC to 150 KC . . . non-frequency discriminating controls . . . internal signal amplitude calibration . . . linear time base from ½ cycle to 50 KC, triggered or repetitive, for both horizontal channels.

S-11-A

The S-11-A INDUSTRIAL POCKETSCOPE is a small, compact (5x7x11 inches), and lightweight (8¾ lbs.) instrument for observing electrical circuit phenomena. The flexibility of the POCKETSCOPE permits its use for AC measurements as well as for DC. The vertical and horizontal amplifiers are capable of reproducing within —2DB from DC to 200 KC with a sensitivity of 0.1v rms/in. . . . repetitive time base from 3 cycles to 50 KC continuously variable throughout its range . . . variations of input impedance, line voltage or controls do not "bounce" the signal—the scope stabilizes immediately.

RAYONIC CATHODE RAY TUBES BY WATERMAN

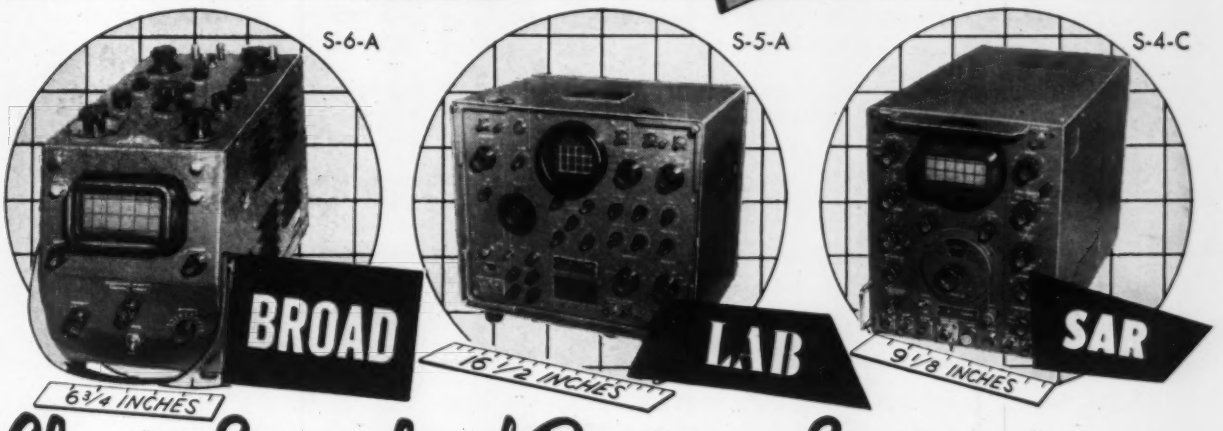
TUBE	PHYSICAL DATA		STATIC VOLTAGE		DEFLECTION*		LIGHT OUTPUT**
	FACE	LENGTH	A3	A2	VERT	HOR	
3JP1	3"	10"	3000	1500	111	150	352
3MP1	3"	8"		750	99	104	33
3RP1	3"	9.12"		1000	61	86	44
3SP1	1.5x3"	9.12"		1000	61	86	44
3XP1	1.5x3"	8.875"		2000	33	80	218

The basic properties of the cathode ray tube that concern the designer or the user are: deflection sensitivity, unit line brightness, line width, static voltage requirements and physical size. A comparison between cathode ray tubes manufactured by Waterman Products Company is shown in the table adjoining. These tubes are available in P1, P2, P7 and P11 phosphors. **3JP1, 3JP7, 3SP1 and 3XP1 are available as JAN tubes.**

For more information circle **17** on inquiry card.

PULSESCOPE by Waterman

The Oscilloscope that Portrays the Pulse



Classic Examples of Precision Engineering...

The PULSESCOPES are cathode ray tube oscilloscopes that portray the attributes of the pulse: shape, amplitude, duration and time displacement. All PULSESCOPES have internally generated markers with the basic difference that in the SAR PULSESCOPE the markers initiate the sweep while in the others the sweep starts the markers.

BROAD

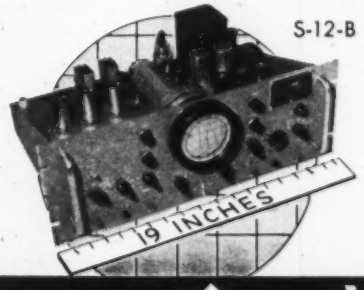
The S-6-A BROAD BAND Scope is a PULSESCOPE in performance, POCKETSCOPE in size. The instrument measures DC as well as AC signals. Unique DC calibration methods permit rapid measurements of either positive or negative, AC or DC signals. Vertical amplifier sensitivity of 0.2v rms/inch, and response to 5 mc within 3DB . . . pulse rise time of 0.1 μs . . . internal markers from 1 to 1000 μs . . . repetitive or trigger sweep from 5 cycles to 500 KC with 5X sweep expansion . . . sweep, marker and DC calibrating voltage available externally. Size 8½ x 6¾ x 13¾ in. Weight 22 lbs. Operates from 50 to 400 cycles at 115 volts AC.

LAB

The S-5-A LAB PULSESCOPE is a JANized (Gov't Model No. OS-26) portable, AC, wide band-pass, laboratory oscilloscope ideal for pulse as well as general purpose measurements. Internal delay of 0.55 μs permits observation of pulse leading edge. Includes precision amplitude calibration, 10X sweep expansion, internal trace intensity time markers, internal trigger generators and many other features. Video amplifier 0.1v p to p/inch . . . pulse rise time of .035 μs or response to 11 mc. 1.25 to 125,000 μs triggered or repetitive sweep . . . internally generated markers from 0.2 to 500 μs . . . trigger generator from 50 to 5000 pps. for internal and external triggering. Operates from 50 to 400 cycles at 115 volts AC.

SAR

The S-4-C SAR PULSESCOPE is a JANized (Gov't Model No. OS-4) portable instrument (31.5 lbs.) for precision pulse measurements for radar, TV and all electronic measurements. Portrays all attributes of the pulse . . . internal crystal controlled markers of 10 and 50 μs available for self-calibration . . . in R operation a small segment of the A sweep is expandable for detailed observation with a direct-reading calibrated dial accurate to 0.1%. Video amplifier band-pass up to 11 mc . . . optional video delay 0.55 μs . . . pulse rise and fall time better than 0.07 μs . . . R pedestal (sweep) 2.4 to 24 μs . . . video sensitivity of 0.5v. p to p/inch. Easily convertible from μs to yards. Operates from 50 to 400 cycles at 115 volts AC.



RAKSCOPE

Because the panel is only 7" high and fits any standard rack, the S-12-B RAKSCOPE admirably fills the need for a small oscilloscope of wide versatility. With all the features of the S-11-A POCKETSCOPE, the RAKSCOPE is JANized (Gov't Model No. OS-11), and has many additional advantages; the sweep, from 5 cycles to 50 KC, is either repetitive or triggered . . . vertical and horizontal amplifiers are 50 mv rms/inch with band-pass from 0 to 200 KC . . . special phasing circuitry for frequency comparison.

WATERMAN PRODUCTS CO., INC.

WATERMAN PRODUCTS

PHILADELPHIA 25, PENNA., U.S.A.

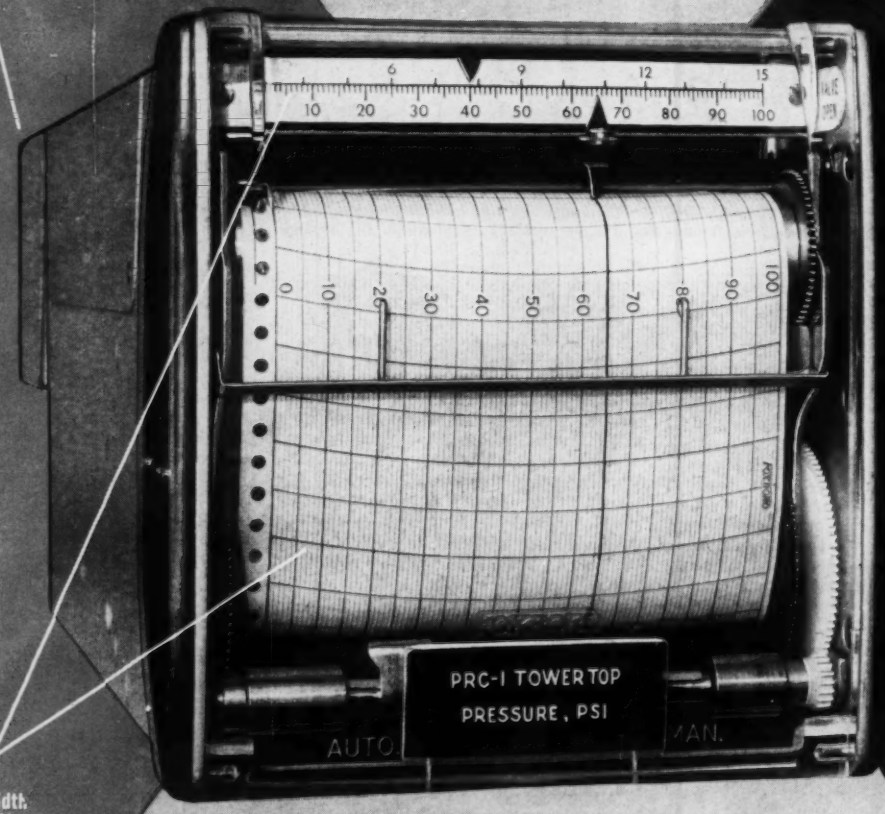
CABLE ADDRESS, POKETSCOPE, PHILA.

Manufacturers of POCKETSCOPES® • RAKSCOPES® • PULSESCOPES® and RAYONIC® TUBES

For more information circle **17** on inquiry card.

NOW...

compactness with nothing sacrificed!



Models to Meet All Your Specifications

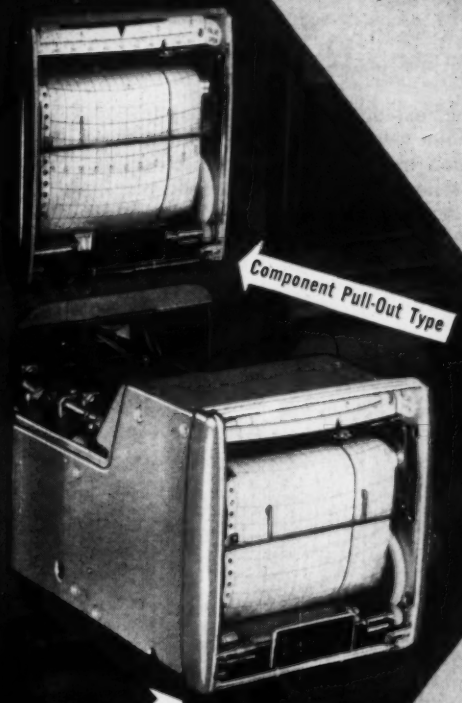
In all the following CONSOTROL instruments, recorder and indicator units can be easily converted in field.

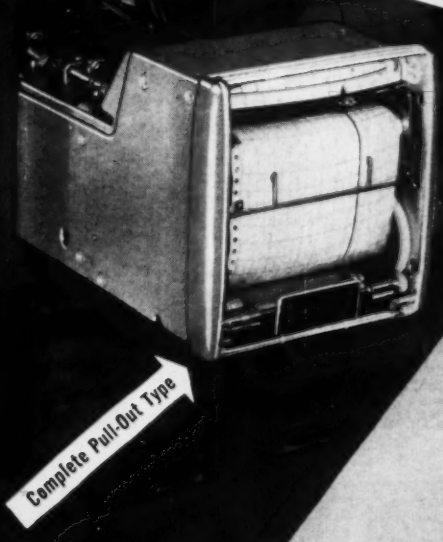
- Recording Control Station with automatic/manual transfer
- Recording Control Station with manual loading only
- Recorder — single or two pen
- Indicating Control Station with automatic/manual transfer
- Indicating Control Station with manual loading only
- Indicator — single or two pointer

For more information circle **18** on inquiry card.

CONSOTROL

small-case panel instruments





Here's the "tops" in centralized recording and control efficiency! CONSOTROL Instruments require the minimum of valuable panel space, yet provide unsurpassed operator convenience, visual accuracy, and ease of maintenance . . . maintain the highest standards of precision and dependability. For example: the simple CONSOTROL method of switching from automatic to manual control requires no memory or extra operations . . . never "bumps" the process. All CONSOTROL charts and scales are full 4-inch width for greatest visibility . . . highest accuracy. When it comes to servicing, there's plenty of "finger room" . . . all parts are uncrowded and easily removable. And just compare inking requirements with other designs. CONSOTROL needs ink filling only once or twice a year! These are only a few of CONSOTROL's advanced design features — available in both fixed-mounting and full pull-out type instruments. Get the complete story. Write for Bulletin 13-18. The Foxboro Company, 468 Neponset Avenue, Foxboro, Mass., U.S.A.

FOXBORO

REG. U. S. PAT. OFF.

Consotrol Process Control

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

For more information circle **18** on inquiry card.

News...

INSTRUMENTS and AUTOMATION

New GE Research Lab

SCHENECTADY, N. Y.—A research facility destined to provide new materials for the future will be dedicated in August at the General Electric Research Laboratory. The new $5 million Metals and Ceramics Building, described as the world's most complete metals and ceramics processing laboratory, will conclude a week-long program of conferences and seminars attended by some of the nation's leading scientists, professors of metallurgy and ceramics, and representatives of the GE operating components to be served by the new laboratory facility.

DR. C. G. SUITS

New $5 million GE Metals and Ceramics Research Bldg.

"The week's activities," according to Dr. C. G. Suits, GE vice president and director of research, "have been planned to demonstrate the growing significance of metallurgy and ceramics as sciences, to emphasize the importance of metallurgy and ceramics to the nation's industry and defense, and to bring attention to the vital role this new building will have in the General Electric Company's future."

Dr. Suits points out that completion of the Metals and Ceramics Building is part of the $13 million expansion program for the Research Laboratory at The Knolls. GE President Ralph J. Cordiner has asserted his expectation that Schenectady will become "the industrial research center of the world."

European School

PHILA., PA.— U. S. technical know-how is being exported.

The Minneapolis-Honeywell Regulator Company announced recently plans for the establishment in England of a technical training school to groom engineers and other technical personnel in the use of automatic control equipment used broadly in the United States. Classes for the first year will comprise M-H personnel from Great Britain, Holland, Switzerland, Sweden, Belgium and Germany. Later plans call for customer "students" from Great Britain and western European industrial firms to attend the school.

This is believed to be the first full-time training school set up abroad by an American manufacturer. Director of the school will be Harry Horton, an Englishman, a member of the firm's subsidiary in Great Britain, Honeywell-Brown Ltd.

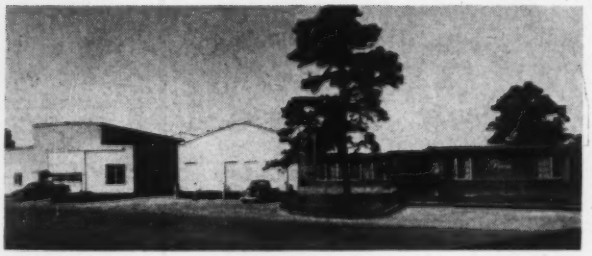
Charles Meech, manager of M-H's International Division, says that the school is patterned after the firm's Industrial division training school in Philadelphia. Last year the U. S. school, now in its twentieth year, graduated its 4,000 student with a year's enrollment of 315 customer "students" representing 204 American companies and firms in nine foreign nations.

Farris Expands

PALISADES PARK, N. J.—As part of a general expansion program covering both its manufacturing and sales facilities, Victor W. Farris, President of the Farris

EDWARD GROTH, JR.

C. W. HANLON



New Houston, Texas plant.

Engineering Corporation and its affiliates, Palisades Park, N. J., has announced the establishment of a new plant at 5400 Clinton Drive, Houston, Texas. At the same time, announcement has been made of several new staff appointments within the Farris organization.

Promoted to Manager of the new Farris Houston plant is Edward Groth, Jr. Appointed as Sales Manager for the Farris Flexible Valve Corporation is Charles W. Hanlon.

New Area Managers include: Charles S. Lewis, cover-

Build SORENSEN REGULATION into your products with these new

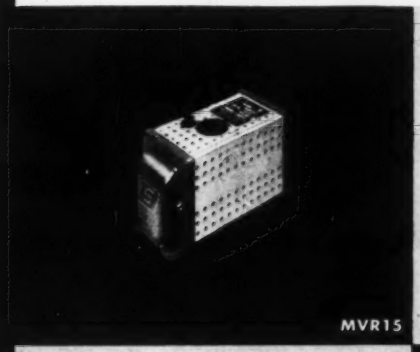
MAGNETIC VOLTAGE REGULATORS

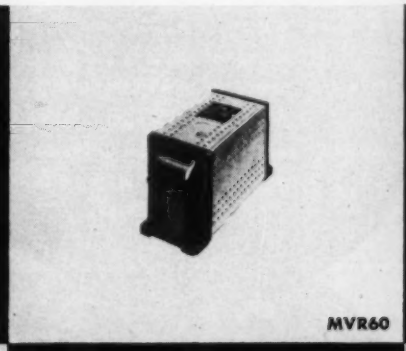
CAPACITIES – 15VA, 30VA, 60VA, 120VA, 250VA, 500VA.

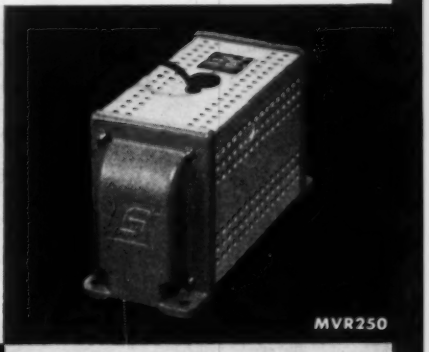
TUBELESS – *trouble free*
COMPACT – *saves space in your equipment*
LIGHTER *than comparable regulators*
GOOD APPEARANCE – *enhances your product*
THERMALLY ISOLATED CASE – *simplifies your design problems*

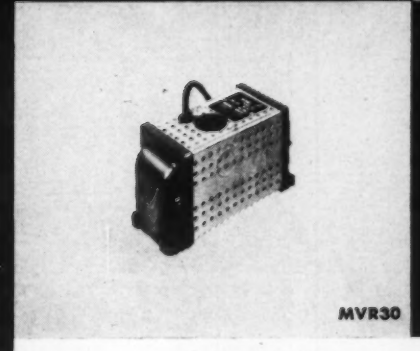
ELECTRICAL SPECIFICATIONS

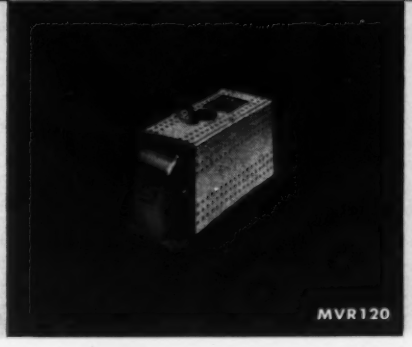
Input voltage range	95-130VAC, 1Ø, 60 cycles.
Output range	115VAC, RMS, 1Ø.
Regulation accuracy	±0.5% against line changes.
Load conditions	±0.5% against line at any given load from 0 to full.
Time constant	From 2 to 6 cycles for line changes.

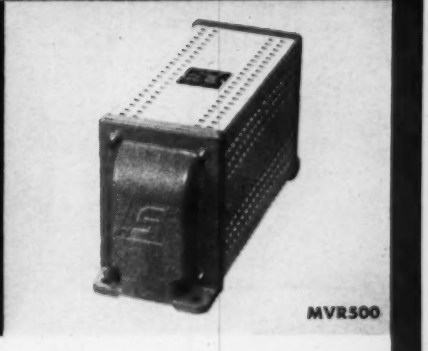

MVR15


MVR60


MVR250


MVR30


MVR120

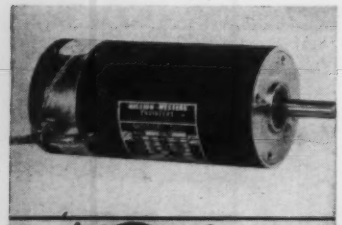

MVR500

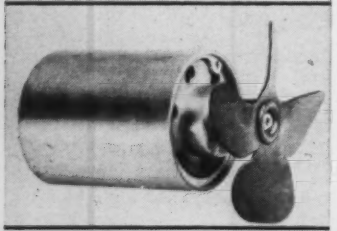
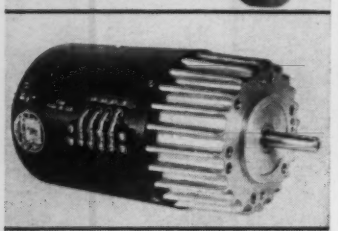
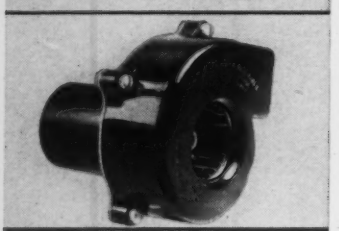
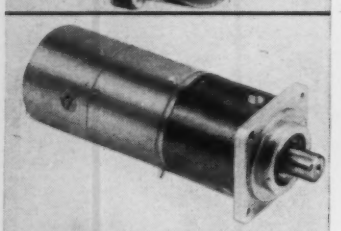
GET MORE INFORMATION: Catalog MVR2 is yours for the asking; gives complete data on the new Magnetic Voltage Regulator line. Contact your local Sorensen representative, or write to General Sales Department, Sorensen & Co., Inc., 375 Fairfield Ave., Stamford, Conn.

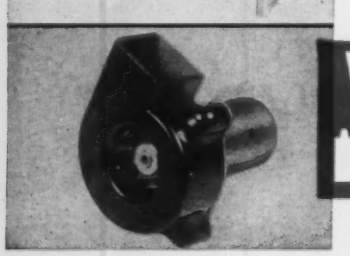
CONTROLLED POWER FOR RESEARCH AND INDUSTRY

SORENSEN

For more information circle 19 on inquiry card.





BE SURE OF

RELIABILITY!

SPECIFY

WESTERN GEAR

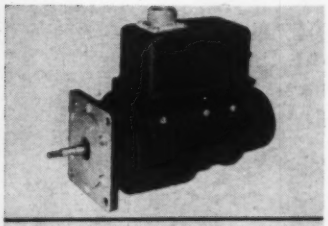
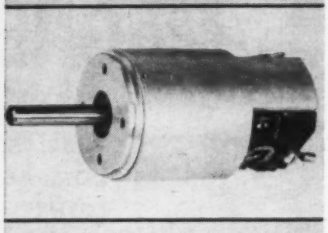
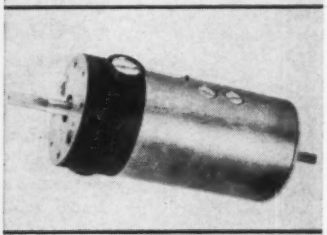
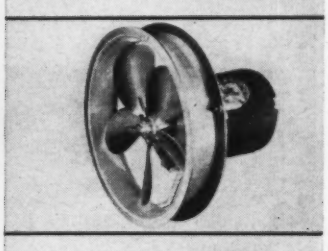
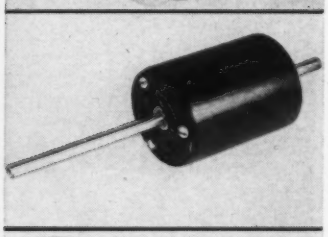
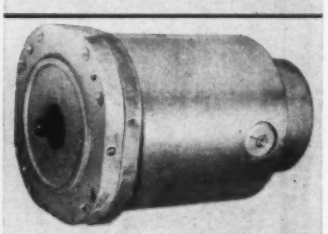
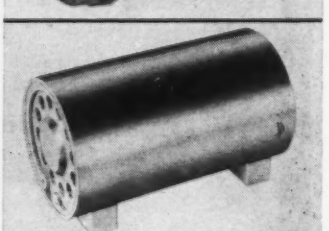
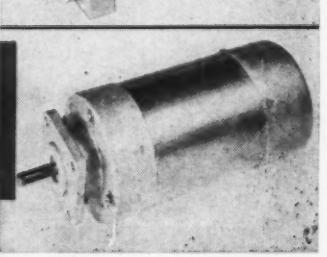
MINIATURE ELECTRICAL ROTARY EQUIPMENT

HERE ARE

9 REASONS WHY!

- die-cast aluminum housings for rigidity
- ball bearings throughout
- stainless steel through bolts
- bonded stators for greater strength
- full protection against humidity and fungus growth
- meet or exceed all AN specifications
- constant inspection and 100% performance testing
- continuing research program to improve techniques and manufacturing methods
- complete engineering service to insure correct application

More than 50 basic motor designs, including axial and centrifugal blower designs, ranging from .001 to 2 HP, from 50 to 1,000 cycles, any voltage range, to fill virtually any specification. Please detail your requirements. Our engineers will make recommendations promptly. Write Executive Offices, Western Gear (Electro Products Division) P.O. Box 182 Lynwood, California.

"The difference is reliability" ★ *Since 1888* 5568

WESTERN GEAR

PACIFIC-WESTERN PRODUCTS | POWER TRANSMISSION GEARS • MACHINERY •

PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.)
SEATTLE AND HOUSTON — REPRESENTATIVES IN PRINCIPAL CITIES

For more information circle **20** on inquiry card.

ing the mid-west sales offices with headquarters in Chicago; Albert F. Stumm for the mid-Atlantic states, with headquarters in Philadelphia and Mr. Groth for the southwest in addition to his other responsibilities in the Houston plant. An Area Manager for Los Angeles will be appointed in the near future.

Wind-tunnel Computer

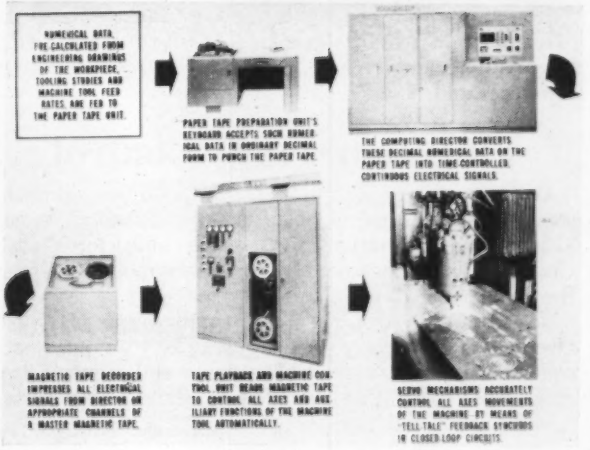
MOFFETT FIELD, CALIF.—A high speed electronic computer has been installed by the world's largest aeronautical research facility. First of its kind in the Bay area, the "Datatron" digital computer will short-cut months of critical data processing on planes and missiles designed for speeds approaching 3,000 miles an hour.

Manufactured by ElectroData Corporation of Pasadena, the 1½-ton computer will do 500 additions or subtractions of ten-digit numbers per second, and 120 multiplications or 85 divisions in the same time. Eleven other "Datatrons" have been installed nationwide to date.

Machine-tool Automation

FOND DU LAC, WIS.—Milling intricately-contoured, low-tolerance workpieces on multi-axis machines completely controlled by magnetic tape—on which entire work cycles have been programmed solely from numerical data—was proved a present-day reality by the Giddings & Lewis Machine Tool Company in a recent four days' demonstration of their new "Numericord" control system operating a Skin Milling machine before high military and aircraft manufacturing officials at the company's Fond du Lac, Wisconsin, plant.

Four major components make up the Numericord sys-


NUMERICAL DATA, PRE-CALCULATED FROM ENGINEERING DRAWINGS OF THE WORKPIECE, TOOLING STUDIES AND MACHINE TOOL FEED RATES ARE FED TO THE PAPER TAPE UNIT.
PAPER TAPE PREPARATION UNIT'S KEYBOARD ACCEPTS SUCH NUMERICAL DATA IN ORDINARY DECIMAL FORM TO PUNCH THE PAPER TAPE.
THE COMPUTING DIRECTOR CONVERTS THESE DECIMAL NUMERICAL DATA ON THE PAPER TAPE INTO TIME CONTROLLED, CONTINUOUS ELECTRICAL SIGNALS.
MAGNETIC TAPE RECORDER IMPRESSES ALL ELECTRICAL SIGNALS FROM DIRECTOR ON APPROPRIATE CHANNELS OF A MASTER MAGNETIC TAPE.
TAPE PLAYBACK AND MACHINE CONTROL UNIT READS MAGNETIC TAPE TO CONTROL ALL AXES AND AUXILIARY FUNCTIONS OF THE MACHINE TOOL AUTOMATICALLY.
SERVO MECHANISMS ACCURATELY CONTROL ALL AXES MOVEMENTS OF THE MACHINE BY MEANS OF "TELL TALE" FEEDBACK SYNCHROS IN CLOSED LOOP CIRCUITS.

CAMBRIDGE
PRECISION INSTRUMENTS

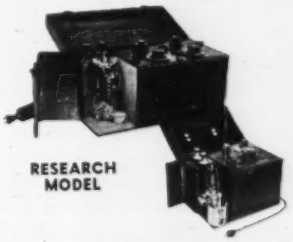
FOR EXACTING PROFESSIONS AND INDUSTRIES

In the past half-century, many important developments of science and industry have been furthered by use of Cambridge Instruments. From its inception, this Company has made precision instruments for exacting professions and industries. Some of the

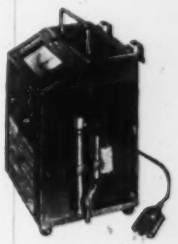
Size:
8.3 x 6.5 x 3.5 cm.
Weight: 0.17 Kg

LINDEMAN-RYERSON ELECTROMETER

This instrument is extensively used for the determination of radioactive emission. Has high sensitivity, good stability and does not require leveling. Send for descriptive literature.



RESEARCH MODEL



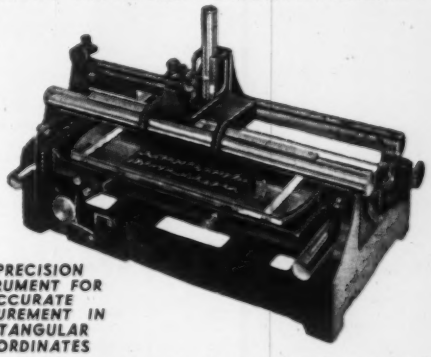
LABORATORY MODEL

INDUSTRIAL MODEL

pH METERS.

The three portable models shown incorporate new and important advantages. AC line operation eliminates battery nuisance. Laboratory and Research Models use electron-ray tubes for precise null-point indication. Industrial model is direct-reading, continuous-indicating; ruggedly built for plant use.

CAMBRIDGE UNIVERSAL MEASURING MACHINE



A PRECISION INSTRUMENT FOR ACCURATE MEASUREMENT IN RECTANGULAR CO-ORDINATES

This instrument measures, in rectangular co-ordinates, records, diagrams or photographic prints, films, or plates. It is suitable for checking reseau, the dividing of scales, pitch of micrometer screws, etc. Magnification x 12.

CAMBRIDGE ALSO MAKES

Moisture Indicators and Recorders, Aero Mixture Indicators, pH Meters and Recorders, CO_2 and Multi-Gas Analyzers and Recorders, Geophysical Seismographs, Electrometers, Voltamographs, Galvanometers, Dissolved Oxygen Recorders, Fabric Permeameters, Exhaust Gas Testers, Surface Pyrometers, Fluxmeters, Vibrographs, Stethographs, Electrocardiographs and instruments for measuring radioactive emission.

Send for Complete Information

CAMBRIDGE INSTRUMENT CO., Inc.
3742 Grand Central Terminal
New York 17, N. Y.

PIONEER MANUFACTURERS OF PRECISION INSTRUMENTS

For more information circle **21** on inquiry card.

PRESENT THIS COUPON AT BOOTH 370

FOR YOUR COPY OF THE MELETRON PRESSURE SWITCH HANDBOOK 4M

NAME _____ TITLE _____

COMPANY _____

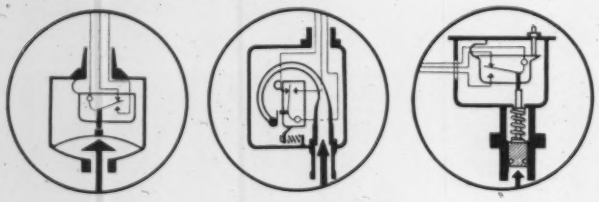
ADDRESS _____

CITY _____ ZONE _____ STATE _____

booth 370

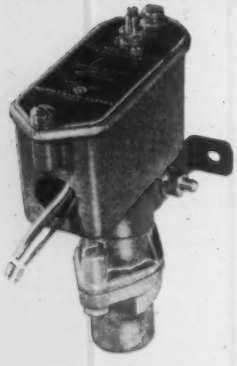
If your job necessitates your knowing the application and function of pressure switches, you will find this an invaluable reference book. It contains such useful pressure switch data as a glossary of terms, diagrams and illustration of switch functions, circuit symbols and a selection chart as well as catalog data on the most complete line of pressure switches. We would like everyone who is interested to receive one, but since this handbook is a rather expensive piece of literature we cannot give them away indiscriminately. We thank you for your interest and cooperation in presenting this coupon. (Mail it, if you are not going to be at the conference.)

SIMPLICITY ITSELF



At the exhibit you may see the Meletron line in booths 368, 369 and 370. It is probably the most complete pressure switch range in standard models. There are Bourdon tube, diaphragm and piston type pressure switches covering just about every practical range and function. As you will quickly note, simplicity is the keynote of all three designs.

THE NEW PISTON PRESSURE SWITCH



Stop in to see the new, piston pressure switch 9612. It accurately senses any system pressure over an adjustable range of 15 to 3,000 PSI, with a proof range of 3,000 to 7,000 PSI and will actuate an electric circuit at any predetermined point on increasing or decreasing pressure. It is particularly suited for application in an automatic production set-up where fast, continuous operation demands millions of cycles from a pressure switch.

BARKSDALE VALVES

PRESSURE SWITCH DIVISION

5125 Alcoa Avenue, Los Angeles 58, California

For more information circle **22** on inquiry card.

NEWS—CONTINUED

tem: (1) a paper tape preparation unit, which punches a master numerical tape with previously-calculated decimal information from part drawings, tooling data and machine feed rates; (2) an electronic computing director, which converts digital information on the paper tape into phase-modulated, time-coordinated command signals recorded on proper parallel channels of a magnetic tape; (3) electronic play-back circuitry, which reads commands off the magnetic tape and sends appropriate electrical control signals to the machine; (4) electromechanical, machine-control units which position machine axes in accordance with taped command signals.

3rd British Instrument Industries' Exposition

The Third British Instrument Industries' Exposition (BIIE) was held at Earl's Court, London, June 28-July 9. The exhibits were good and fully representative of the many diverse instruments now being produced in England.

Many American instrument manufacturers took this opportunity to keep abreast of foreign developments in instrumentation. Mr. Henry F. Dever, President of the Brown Instruments Division of Minneapolis-Honeywell Regulator Company, and President of the Scientific Apparatus Makers of America, is shown (second from left) visiting the exhibit of *Instruments and Automation* at the BIIE. With Mr. Dever are Mr. J. C. N. Hughes (left), Miss Knight, and Mr. W. H. Edwards, representing *Instruments and Automation* in England.

Filtration Plant Control

OGDEN, UTAH.—A contract to build an automatic transmission system to monitor operations of a new $750,000-water-filtration plant being built for Ogden, Utah, has been awarded to the Minneapolis-Honeywell Regulator Company.

The control system, developed by the firm's Industrial Division engineers, will utilize a variety of pneumatic and electronic instruments to measure and regulate flow, degree of acidity and the filtering stages. The control

Continued on page 1202

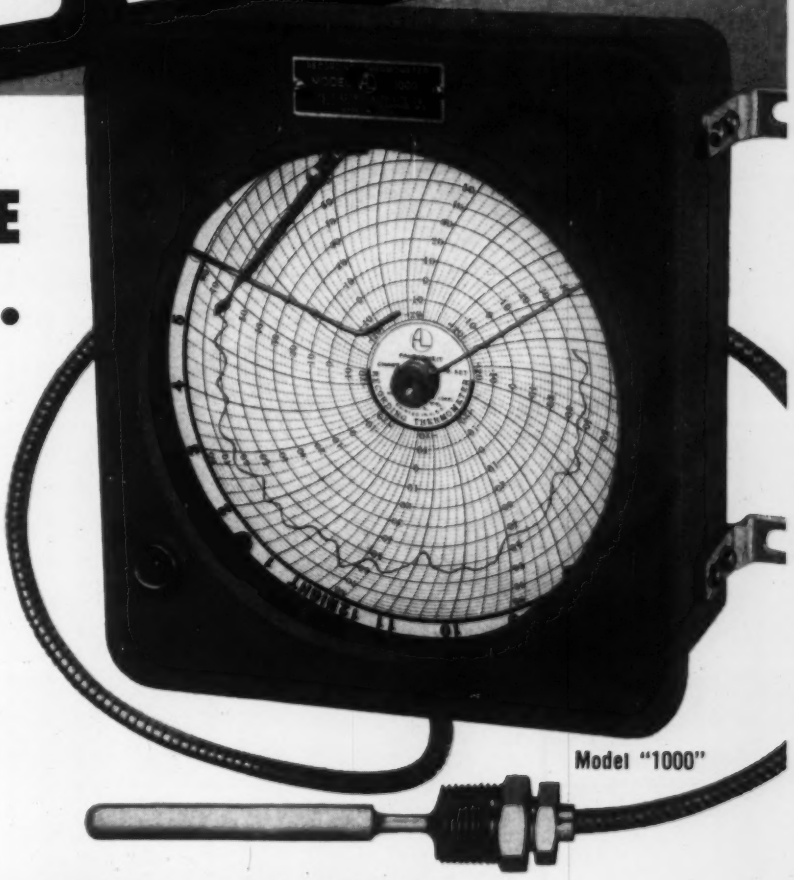
AUTO-LITE

SEE THE
AUTO-LITE EXHIBIT
Instrument & Automation Show
BOOTH C-526/1

TEMPERATURE RECORDERS...

Newly designed, Model "1000" Auto-Lite Recorder gives permanent proof of temperature behavior.

- 6″ clear reading chart; various standard ranges from minus 40°F. to plus 550°F.
- 3 standard types; choice of 24-hr. or 7-day cycle.
- Electric or mechanical chart drive.
- With capillary tubing for remote reading. Priced from $49.50



Model "1000"

TEMPERATURE INDICATORS...

Auto-Lite offers many thermometer styles, permitting plant-wide temperature observation at low cost. Standard temperature ranges from minus 60°F. to plus 750°F. Send for latest catalog showing various types of Auto-Lite Indicators and Recorders.

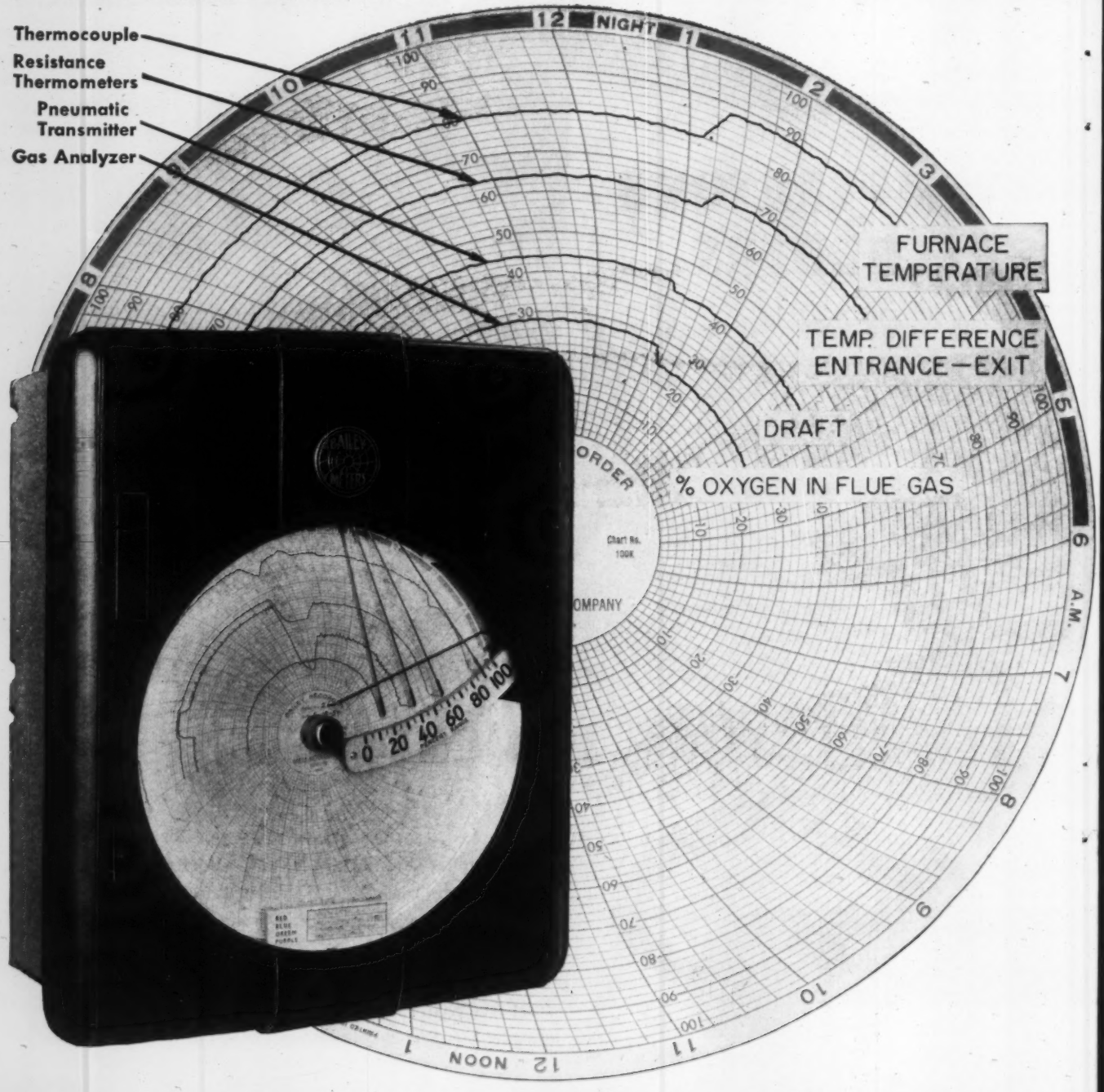
Model F-1 temperature indicator — Rigid stem or capillary tubing for EYE-LEVEL remote reading. Priced from $22.

THE ELECTRIC AUTO-LITE COMPANY
INSTRUMENT AND GAUGE DIVISION
TOLEDO 1, OHIO
NEW YORK • CHICAGO • SARNIA, ONTARIO

For more information circle **23** on inquiry card.

NOW—Bailey Brings You a

Now you can record signals from electric pickups and pneumatic transmitters on the same chart.



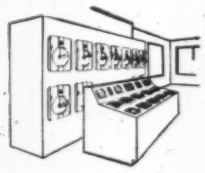
Get the records you need on the same chart. Plug-in receivers are available for these other variables—

% combustibles	density	flow	pH	ratio	speed
combustion	differential	liquid level	position	smoke density	temperature
conductivity	draft	% oxygen	pressure	specific gravity	vacuum

For more information circle **24** on inquiry card.

New and Better Way— to Compare Temperatures

Records of related variables on one chart simplify analysis



To coordinate related records on a single linear chart—here is a new D-C receiver unit that can be plugged into the Bailey Receiver Recorder along with A-C receivers and pneumatic receivers.

This means that you can compare temperature with other related variables on the same chart regardless of pickup characteristics or range spans. You can have combinations such as: Furnace Temperature, Stack Temperature, Per cent Oxygen, and Per cent Combustibles; or Firing End Temperature, Feed End Temperature, Kiln Speed, and Hood Draft; or Heat Exchanger Entrance and Exit Temperatures.

Check These New Advantages

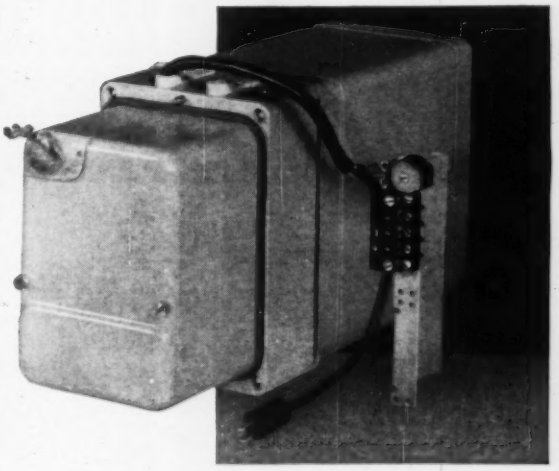
A Linear Chart for all types of thermocouples and thermopiles eliminates the nuisance and expense of stocking separate types of charts for different elements—and the need for interpolation tables. Direct reading saves time and reduces errors.

Process Changes Quickly Accommodated with a minimum parts and chart inventory. The unique unitized construction of the Bailey Receiver Recorder permits you to select and "customize" your own combination of receiver and controller units. Electronic and pneumatic receivers as well as controllers and retransmitters are interchangeable in the four frame slots of the Bailey Receiver Recorder.

Measurement and Control is Continuous, with no automatic or manual standardization periods required. You always get the same straight line relationship, due to the *cam action* (a Bailey innovation).

THE BAILEY RECEIVER RECORDER OFFERS:

1. **Extreme Flexibility of Application.** You can record any four measured variables, using D-C, A-C or pneumatic receivers (or any two, together with their controllers). Four identical frame slots permit complete interchangeability of receivers and controllers as required by changing processes or circuits.
2. **Four Telemetered Measurements on a Single 12" Circular Chart.** First cost and installation expense is at a minimum. Operating economy is at a maximum—and remoteness of measuring location makes no difference.
3. **Faster, Easier Servicing.** The exclusive Bailey sealed ink sacs and capillary pens eliminate day-to-day inking; sacs normally need replacement only once a year.
4. **Faster, Easier Ordering from Stock.** Bailey's exclusive standardized unit design permits selection of any combination of recording receivers to fit your needs. You can order your own custom assembly from stock, in a minimum of time, at a minimum of expense.



Plug-in type D-C Receiver for Bailey Receiver Recorder

The unique cam-type compensator on this receiver permits use of a single standard 12" diameter linear chart, regardless of the characteristics of the thermocouple, thermopile or other pickup used.

Write for complete specifications — use handy coupon below

G35-2

BAILEY METER COMPANY

1041 IVANHOE ROAD

CLEVELAND 10, OHIO

Controls for Power and Process

BAILEY METERS

COMBUSTION
TEMPERATURE
PRESSURE
GAS ANALYSIS
LEVEL
RATIO
FLOW

Bailey Meter Company
1041 Ivanhoe Rd., Cleveland 10, Ohio

Please send me product specifications on the new Bailey Receiver Recorder, as follows:

☐ With D-C Receiver—Spec. E12-4

☐ With A-C and Pneumatic Receivers—Spec. E12-5

Name_____

Title_____

Company_____

Street and Number_____

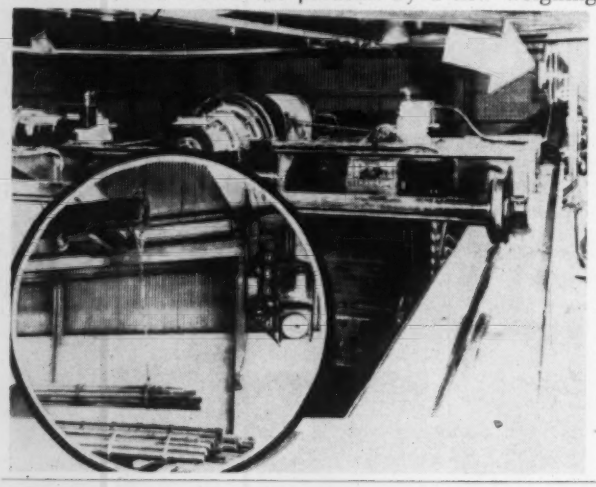
City_____ Zone____ State_____

For more information circle **24** on inquiry card.

system feeds into a centrally located master control panel which graphically portrays operation of the entire plant, which will treat more than 9,720,000 gallons of water daily, increasing the city's safe drinking water capacity by 25 per cent. Scheduled for completion this August, it is the first of four plants to be erected in a $5-million expansion program for northern Utah.

Crane Saves Money

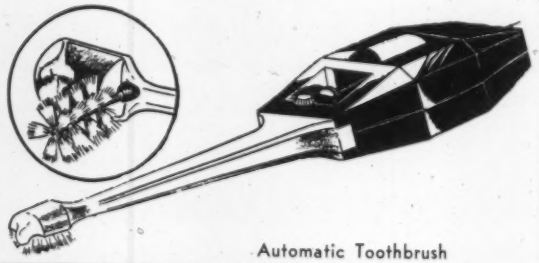
PHILA., PA.—SKF Industries, Inc., Philadelphia, recently experienced increasing maintenance costs and downtime on mechanical platform scales in the tubing warehouse, and solved the problem by a new weighing system which is saving time and money. With the new system, SKF can lift and weigh simultaneously, reading the load weight on an "Atcotran" Dial Indicator from the electronic signal fed to it by an ATC pressure transducer mounted on two hydraulic load cells on top the crane from which the load is suspended. This equipment was supplied by the Automatic Temperature Control Co. of Philadelphia. To accomplish this, SKF installed a Gleason WB60-15 cable reel (Gleason Reel Corp., Milwaukee 3, Wis.) which eliminates the use of collector rings, contacts, or electrical parts and does not twist the cable. The installation has been so satisfactory, SKF has removed the old mechanical scale system.



Non-industrial Automation

Automation is invading the homes and trout streams as well as the plants and factories of America. New automation devices for the home include electronic "RadaRange" ovens and automatic toothbrushes; fishermen will welcome the new automatic Fish-Scaler.

The RadaRange, using radar-frequency dielectric heating, can increase cooking speed by a factor 5 to 15 (ex-



Automatic Toothbrush

DU PONT offers
A POSITION OF RESPONSIBILITY in
Instrumental Measurement of Process Variables

The Engineering Service Division of duPont's Engineering Department now has one opening for a graduate engineer whose responsibilities will include trouble-shooting, consultation, and technical assistance. Duties will involve the application of infra-red and ultra-violet spectroscopy to automatic analysis of chemical process fluids and the application of instruments for measuring viscosity, temperature, pressure, flow, and other process variables.

The successful applicant will be expected to have substantial experience in research, application, consulting, or development of techniques for measuring process variables.

DU PONT
REG. U.S. PAT. OFF.

Please send complete resume, including details of education and experience, to:
Mr. J. C. Costello, Jr.
Personnel Section, Engineering Dept.

Better Things for Better Living
...through Chemistry

E. I. du Pont de Nemours & Co., Inc., Wilmington 98, Delaware

Scientific Enclosures Quickly Assembled!

Widney DORLEC
CABINET COMPONENTS

The Widney-Dorlec Cabinet System, consisting of a series of pre-fabricated, dural die-cast corners, extruded dural sections and other special components, now makes it possible to build modern, fully-radiused cabinets to any set of dimensions without special tools!

For Free Catalog & Price List, write to Dept. IA-85
BRITISH INDUSTRIES CORPORATION
164 Duane Street New York 13, N. Y.

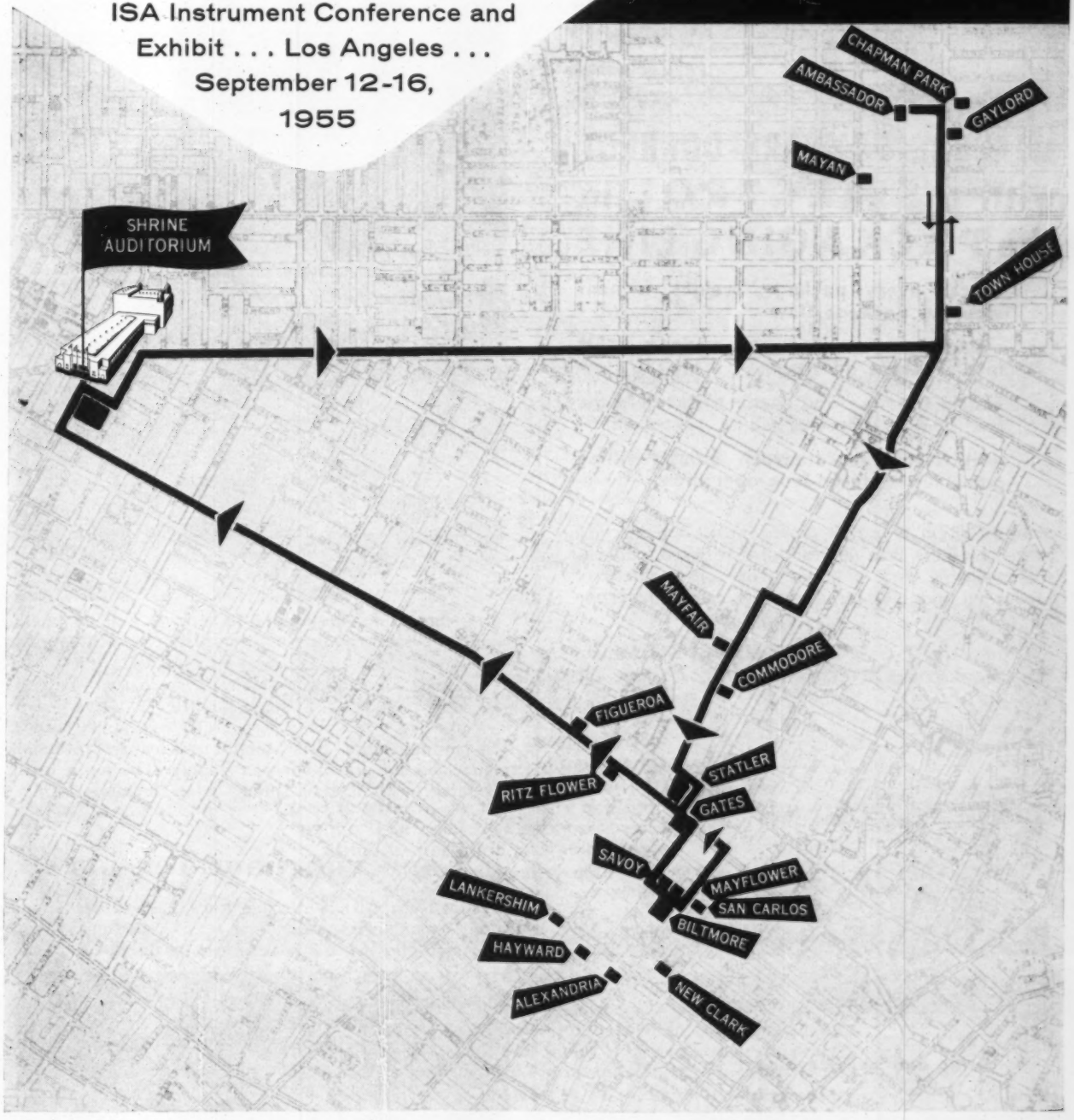
For more information circle **26** on inquiry card.

Swagelok®

does it again...

Every 15 Minutes Between Your Hotel and the Shrine Auditorium During the ISA Instrument Conference and Exhibit . . . Los Angeles . . . September 12-16, 1955

FREE Swagelok SHUTTLE BUS SERVICE



For departure times and boarding locations, see Swagelok Shuttle Bus Schedules in your hotel lobby. I hope the convenience of this service will help make your stay in Los Angeles even more pleasant.

Fred A. Lennon

CRAWFORD FITTING COMPANY

MEASURE-COMPARE-CORRECT with a SELECTROL in the PACKAGING LINE

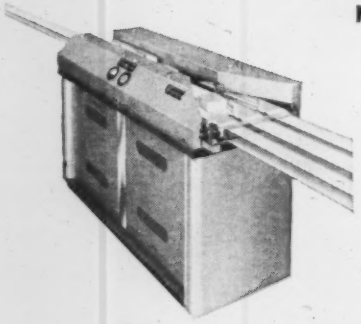
- . . . checks every package, weighs without stopping package flow
- . . . rejects over-weights and under-weights into separate groups
- . . . charts average and range of weights for statistical control of filling operation
- . . . with electronic controls, adjusts filling machines in closed-loop operation

SELECTROL is a time-proven production machine backed by more than 40 years of experience in industrial weighing, and is in use today on hundreds of production lines both for checkweighing and inspection by weight.

Write for details on how SELECTROL can eliminate the inaccuracies of spot checking, save time and products.

SELECTROL

MODEL 1200



Fits into any production line. Available with or without statistical control equipment. Provides accurate weight checks at speeds up to 100 units per minute.

Sales and Service Coast to Coast

Exact Weight Scales

Better quality control

Better cost control

THE EXACT WEIGHT SCALE COMPANY

951 W. Fifth Avenue, Columbus 8, Ohio

In Canada: P. O. Box 179, Station S, Toronto 18, Ont.

For more information circle **28** on inquiry card.

NEWS—CONTINUED

Rada Range

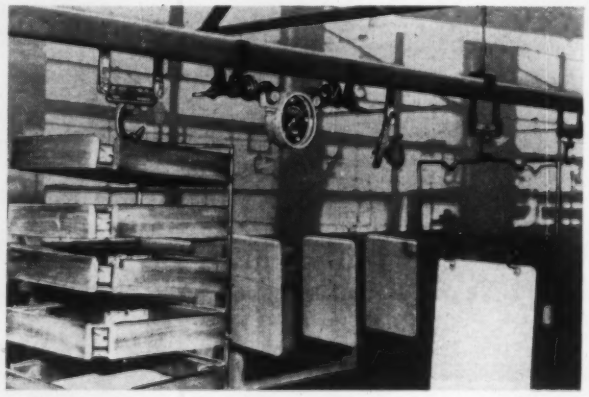
Fish-Scaler

citing figures for restaurant owners as well as housewives). It is offered by Raytheon Mfg. Co., Waltham 54, Mass.

The new automatic, portable "Fish-Scaler," (American Homecraft Co., Chicago 41, Ill.) enables fishermen to scale fish 5 times faster, and no muscle needed. The new automatic "Bren" tooth brush features reversible motor and integral 3-v power supply. The tooth brush is offered by Bren, 1608 Quincy Ave., Dunmore, Pa.

Conveyor-chain Tension

TRUMANN, ARK.—An ingenious method of using a Dillon Dynamometer to check the tension in a moving conveyor chain has just been announced by the Poinsett Lum-



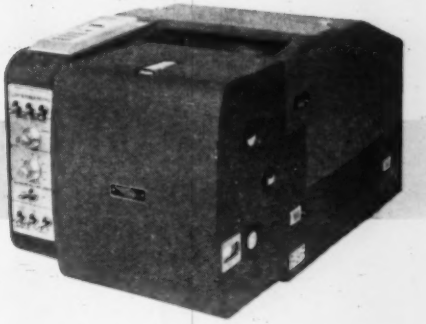
There's always INSTRUMENT News from

SEE . . . These and many other Advanced Midwestern Instruments

WESCON and I. S. A. SHOWS

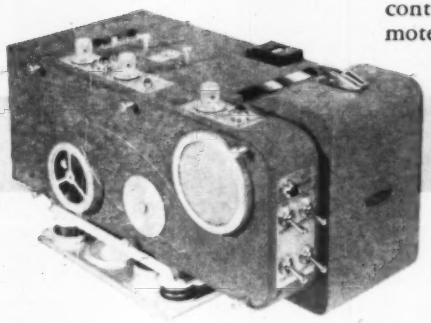
BOOTHS 1216-1217 BOOTHS 341-342

MIDWESTERN INSTRUMENTS



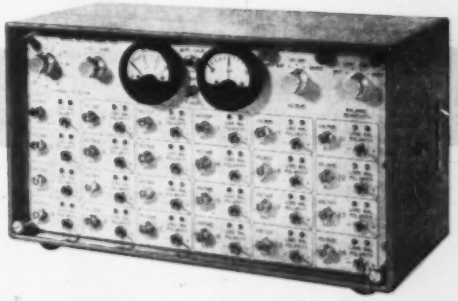
MI 590 OSCILLOGRAPH — SPECIALLY DESIGNED FOR REMOTE CONTROL

Every feature necessary for successful use as a flight-test instrument. This new design incorporates all the rugged dependability of previous models *plus* new features which provide possibilities for controlling the oscillograph from a remote location.



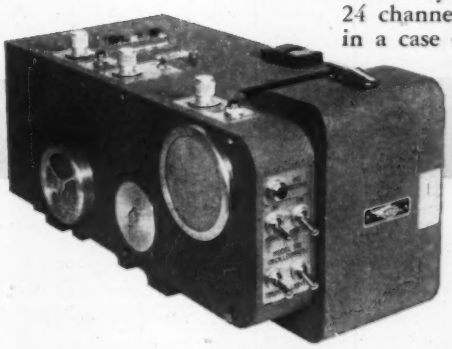
MI 580 OSCILLOGRAPH — DEPENDABLE FOR FLIGHT-TEST . . . FIELD . . . OR LABORATORY

This model provides 14 channels of separate data, observable on full-width viewing screen while in operation, and recorded at selected speeds ranging from ½ to 44¾ inches per second. Designed for flight-testing, field or laboratory applications.



MI 435 BRIDGE BALANCE UNIT VERY SMALL . . . VERY VERSATILE

The use of miniature precision components and rugged, aluminum alloy case combine to produce a general purpose instrument for laboratory or flight-test use. The smallest possible size, with versatility of operation and application; 24 channels, plus automatic calibration, in a case 6″ x 11″ x 5-11/16″.



MI 581 OSCILLOGRAPH — EXTREMELY VERSATILE FOR USE UNDER MOST RUGGED CONDITIONS

Similar to the 580 in basic design, this model includes many extra features with only a minimum increase in size. It also contains a No-Record Indicator, Burn-Out Indicators, Automatic Record Numbering, Captive Fasteners, and Automatic Record-Length Control.

Write for Complete Information

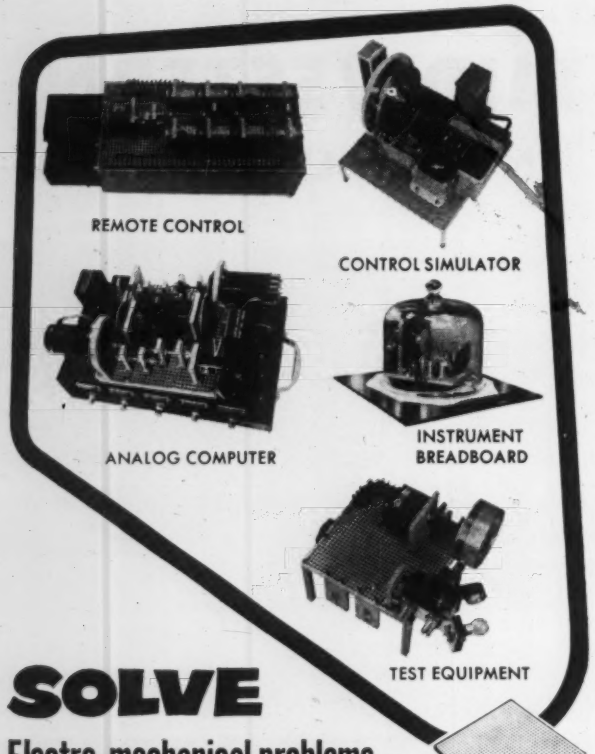
MIDWESTERN INSTRUMENTS

P. O. BOX 7186 PHONE Riverside 7-1331

TULSA, OKLAHOMA

MIDWESTERN MI INSTRUMENTS

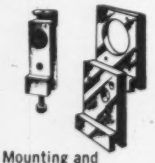
For more information circle **29** on inquiry card.

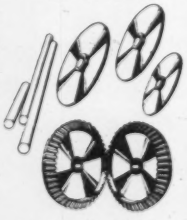


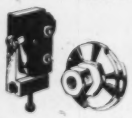
SOLVE

Electro-mechanical problems... IN THE LAB! with Servomechanisms' efficient, economical Mechanical Development Apparatus

Pictured above are typical Mechanical Development Apparatus (MDA) assemblies, complete with electrical components. MDA is an assortment of standardized, precision-built, mechanical components designed for the purpose of simulating instrument and control systems in the breadboard phase of development. The apparatus makes designing extremely fast and economical. An appropriate group of these versatile units can be quickly assembled into a desired mechanism. The components lend themselves to endless use and re-use due to flexibility of design. Only a small assortment is needed to cover a multitude of problems. Prove out your design, quickly and economically with these versatile "tools."







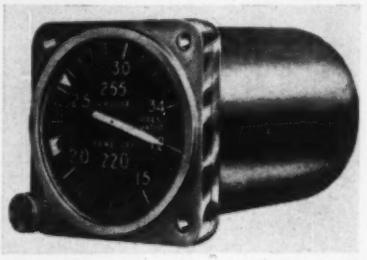
SERVOmechaNISMS INC.

For complete information write for catalog to...
COMPONENTS DIVISION
625 Main Street
Westbury, L. I., N.Y.

For more information circle 30 on inquiry card.

ber and Manufacturing Company of Trumann, Ark. This check is applied periodically to 13 separate drive units on the conveyor, thus assuring equal tensions at all points. It is not necessary to halt the movement of the chain to break or loosen it to attach the dynamometer. Instead, the instrument is merely bolted on the chain while in motion. Slack is then taken up on the chain at that point by a screw arrangement so that the full tension is thrown on the Dynamometer, and a reading in pounds is taken. Time needed to position the dynamometer at each of the 13 check points is only from 45 seconds to one minute.

A-F Uses Pressure Ratio Indicators



WRIGHT AIR FORCE BASE, OHIO.—Successful results have been obtained in tests performed on Kollsman Pressure Ratio Indicators by the Air Force at Wright Air Force Base—and a $50,000 contract has been signed with McDonnell Aircraft Corp. for use of the PRI in the F-101 Voodoo twin-jet Air Force fighter. The PRI indicates the ratio of total pressure at tailpipe and inlet, and thus helps indicate jet-engine performance, optimum power setting, etc. The Pressure Ratio Indicators are supplied by Kollsman Instrument Corp., Elmhurst, N. Y.

Magnetics in Production

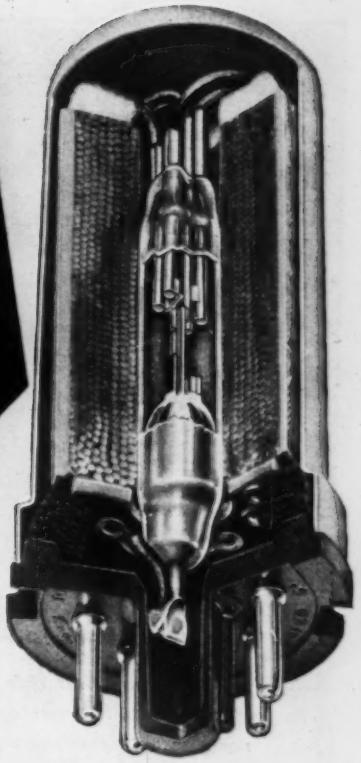
SPRINGFIELD, OHIO.—Buckeye Incubator Co., Springfield, fabricates its products from cold-rolled galvanized sheet steel. Production rate was limited by the speed which the operator could disengage the oiled sheets from one another and pass them to a slitter. Adding a small permanent-type "sheet-fanner" magnet at the start of the line increased production from 10 to 15 percent. The "sheet-fanner" magnets are made by Eriez Mfg. Co., Erie, Pa.

Auto Engine Analyzer

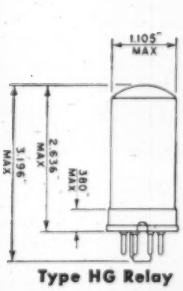
NEW YORK, N. Y.—An electronic instrument for quick and accurate diagnosis of automotive engine ills, has been developed in the research laboratories of Socony-Vacuum Oil Company, Inc., New York. The "Type 901 Engine Analyzer" will be manufactured and sold by the

(*Continued on page* 1214)

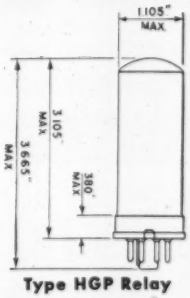
Does a Billion Operations -with no maintenance- interest YOU?



• Cutaway view of HG Relay showing how wick action keeps the mercury at the contacting surfaces continuously replenished.



Type HG Relay



Type HGP Relay

New CLARE Mercury-Wetted Contact Relays meet ALL requirements of today's high-speed switching devices

• If you design high speed switching machines or devices which demand accuracy and dependability of the highest order, you should know ALL about the new CLARE Mercury-Wetted Contact Relays.

CLARE Type HG and HGP Relays offer a combination of high speed, high current- and voltage-handling capacity, and extraordinary uniformity of performance over very long periods.

The relays consist of a magnetic switch, hermetically sealed in a high pressure hydrogen atmosphere in a glass capsule, and a coil, enclosed in a steel vacuum-tube-type envelope which has a standard medium-sized octal base. Platinum contact surfaces are continually wetted with mercury by means of a capillary connection to a mercury reservoir below the contacts. Type HGP Relays can be factory-adjusted to provide either biased or polarized operating characteristics.

For complete information on the new CLARE *Type* HG *and* HGP *Mercury-Wetted Contact Relays, contact your nearest* CLARE *representative or address C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois.*

Send for CLARE Sales Engineering Bulletin No.120

CLARE RELAYS | ***FIRST*** **in the industrial field**

For more information circle **31** on inquiry card.

CLARE Type HG and HGP Relays are built to meet the exacting requirements for—

Computing machines	Servo-mechanisms
Sorting machines	Relay amplifiers
Tabulating machines	High-speed keying relays
Totalizers	Signaling devices

All kinds of high-speed switching devices

Outstanding features of CLARE Type HG and HGP Relays

ELECTRICAL FEATURES

LONG LIFE: Conservative life expectancy of over a billion operations when operated within ratings.

HIGH SPEED: Give consistent performance at speeds up to 60 operations per second.

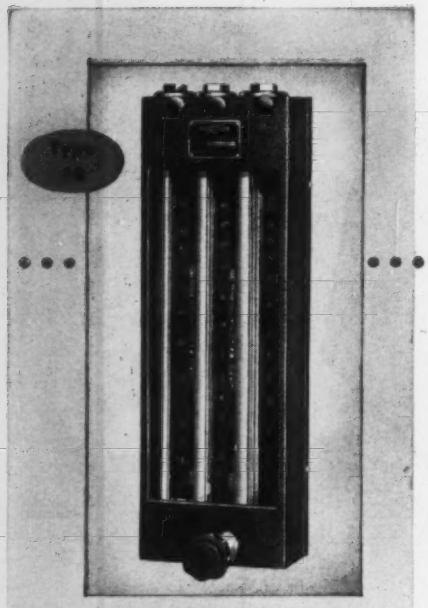
HIGH CURRENT—and voltage-handling capacity (up to 5 amperes, and up to 500 volts).

UNIFORMITY: Operating time varies by only about 0.1 millisecond under constant drive conditions.

NO CONTACT BOUNCE

MECHANICAL FEATURES

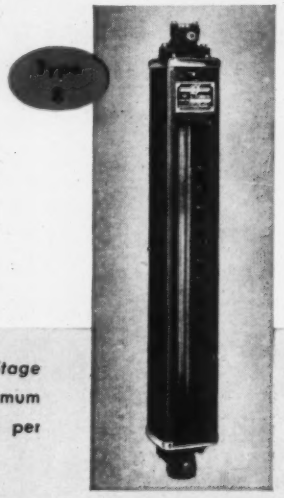
- Small chassis space required
- Convenient plug-in mounting
- Environment-free
- Tamperproof
- High sensitivity
- Maintenance-free
- No contact wear
- Adjustment cannot change

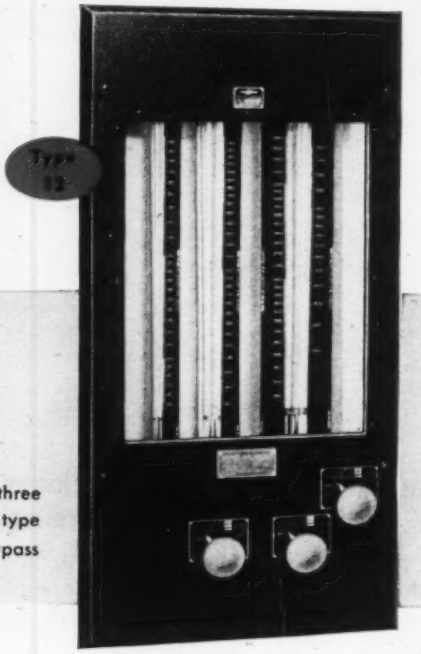


DO YOU USE FLOWMETERS FOR LABORATORY RESEARCH OR PRODUCTION?

COX FLOWMETERS

are designed for flow rate measurement of fuels (such as gasoline, kerosene, diesel and jet fuel) and of many liquids and gases. They are built for use in the laboratory, in a wide range of production processes, or for a combination of the two.





For the Laboratory: *Type 10 Multiple Stage Flowmeters,* designed as a compact laboratory instrument for precise measurement of smaller fluid flow rates.

For Production: *Type 8 Single Stage Flowmeters,* engineered for a maximum flow capacity of 50,000 pounds per hour.

For Both: *Type 12 Multiple Stage Flowmeters,* available in three series — the 40, the 90, and the 100. Each has logarithmic type scales for excellent readability and can be equipped with a bypass orifice to greatly increase flow capacity.

Individually graduated scales; patented "Inner Wall" guides that insure perfect float centering within the metering tube; and extra-sensitive floats are a few of the major features of Cox Flowmeters. Scales are graduated for a specific fluid. Scales for metering other fluids can be easily interchanged. Multiple Stage Flowmeters are available for wide flow ranges, and bypass orifices can be built in which greatly increase the flow capacities without increasing panel space required.

The Type 12, 40 Series Flowmeter, available in single and multiple-stage units, is firmly established as the most accurate variable-area flowmeter now made. Each individually graduated logarithmic scale is accurate to within ±½ percent of the actual flow at any point on the scale. It is readable to within ±¼ percent of indicated flow at any point.

Look for Other **CRL** *Products*

- AIR FLOWMETERS
- CARBURETOR FLOW STANDS
- ENGINE INDICATORS
- FLOWMETER CALIBRATING STANDS
- FUEL NOZZLE TEST STANDS
- MAGNETIC THICKNESS GAGES
- VIBRATION RECORDING EQUIPMENT
- BALANCED ELECTRONIC EQUIPMENT FOR PRESSURE AND VIBRATIONS

Commercial Research Laboratories, Inc.

20 BARTLETT AVENUE • DETROIT 3, MICHIGAN

Makers of REGISTERED TRADE MARK *Since 1912*

For more information circle **32** on inquiry card.

you are invited to attend

THE SECOND INTERNATIONAL

AUTOMATION

EXPOSITION

NOVEMBER
14-17, 1955

NAVY PIER
CHICAGO

WHAT IS AUTOMATION?

Automation is the substitution of mechanical, hydraulic, pneumatic, electrical, and electronic devices for human organs of observation, decision, and effort. It is not a new art or technique. It has been with us a long time; inventors started to add special controls to hand weaving machines as early as 1678.

Automation is a means of achieving the higher productivity and lower costs which add up to an expanding economy. The job remaining is the managerial and engineering task of recognizing the situations in industry which offer the greatest opportunity for return from the application of automation to manufacturing processes. The International Automation Exposition is designed to bring together, under one roof, the basic equipments that make automation possible.

plus these symposia and conferences

Six 2-hour lecture-demonstration sessions on:

- **Electronic Computers**
- **Conveyor Automation**
- **Laboratory Automation**

Cooperating with the Show Management,

The University College, University of Chicago will hold

- **Two-day Conference—"Automation for the Office"**

Armed Forces Chemical Association, Midwest Chapter, will hold

- **One-day Conference on Electronic Computers**

for symposia and conference registration details, write to:

Richard Rimbach Associates, Management
Second International
Automation Exposition
845 Ridge Avenue
Pittsburgh 12, Pennsylvania

at the world's most important show

YOU WILL MEET

THESE TOP-RANKING COMPANIES*— EXHIBITORS AT THE SECOND INTERNATIONAL AUTOMATION EXPOSITION

Advance Electric & Relay Co.
A'G'A' Div., Elastic Stop Nut Corp.
Allegany Instrument Co.
Allied Steel & Conveyors, Inc.
American Etamic Corp.
American Helicopter Div., Fairchild Engine Corp.
American Television & Radio Co.
Analytical Measurements, Inc.
Assembly Products, Inc.
Austin Company
Automatic Electric Sales Company
Automation Engineering Lab.
A-V Manufacturing Corp.
Avion Instrument Corporation
Beede Electrical Instrument Co.
Bendix Computer Division
Berkeley Div., Beckman Instruments
Bowmar Instrument Corporation
Brinkmann & Co., C. A.
Burndy Engineering Co.
Byron Jackson Company
C. P. Clare & Company
Clary Multiplier Corp.
Clevite Brush Development Co.
Coleman Engineering Company
Computer Control Co., Inc.
Counter and Control Corporation
Crawford Fitting Company
Dage TV Division, Thompson Products
Davies Laboratories
Detectron Corp., Computer-Measurements Div.
Dialight Corporation
Doelcam Division, Minneapolis-Honeywell
Dubois Engrg. & Mfg. Co.
Du Mont Laboratories, Inc., A. B.
Dynamic Gear Company
Eastern Precision Resistor Corp.
Eder Instrument Company
Electric Indicator Co.
Electric Regulator Corporation
Electronic Associates
Electronic Control Systems, Inc.
Elematic Equipment Corporation
Encyclopedia Britannica
Epsco, Inc.
Eriez Manufacturing Company
ETA Products
Farrand Optical Co., Inc.
Feedback Controls, Inc.
Femco, Inc.
Ferrara, Inc.
Fischer & Porter Company
Gaertner Scientific Corporation
General Mills Mechanical Division
General Precision Labs.
G. M. Giannini & Company, Inc.
Russell T. Gilman, Inc.
Globe Industries, Inc.
Goodyear Aircraft Corporation
Loren F. Green & Assoc.
Gurley Co., W. & L. E.
Hammarlund Manufacturing Co.
A. W. Haydon Company
Hays Corporation
Heat Timer Corporation
Karl Heitz, Inc.
Hoke, Inc.
Howard Industries
Hycon Manufacturing Company
Industrial Control Panel Company
Institute of Radio Engineers
Instrof, Inc.
Instrument Development Labs., Inc.
Instruments Publishing Company
International Business Machines Co.
International Standard Trading Corp.
James Vibrapower Co.
Kay Electric Co.
Kellogg Switchboard & Supply Co.
Kleinschmidt, Inc.
Kulka Electric Mfg. Co.
J. B. Lansing Co.
Larson Instrument Company
Lehigh Chemical Products Co.
Librascope, Inc.
L. & O. Research & Dev. Co.
Logistics Research Co.
Magnasync Mfg. Co., Ltd.
Magnetic Research Corp.
Malco Tool Mfg. Co.
Metrotype Corp.
Moog Valve Co., Inc.
Morrow Products, Inc.
Mycalex Corporation of America
Nash Engineering Corporation
National Cash Register Co.
North American Aviation Corp.
North Electric Mfg. Co.
Optronics
Pak-Rapid, Inc.
Panellit, Inc.
Pedersen Electronics Co.
PIC Design Corp.
Polarad Electronics Corp.
Post Machinery Co., Electronic Prod. Div.
Potter & Brumfield Mfg. Co.
Potter Instrument Company
Precision Scientific Company
Production Instrument Company
Radio Frequency Labs., Inc.
Raycon Corp.
J. B. Rea Company
Republic Manufacturing Company
Revco, Inc.
Saffro-Gettleman Co.
Sensitive Research Instrument Co.
Sorensen & Co., Inc.
Soroban Engrg., Inc.
Standard Electrical Products Co.
Standard Electronics Co.
Standard Electronics Research Corp.
Sterling Mfg. Co.
Streeter-Amet Company
Stromberg Carlson Co.
Superior Electric Company
Surprenant Manufacturing Co.
Swiss Jewel Co.
Techniflex Corporation
Telex, Inc.
Tube Turns Plastics, Inc.
Uehling Instrument Company
Veeder-Root, Inc.
Victor Adding Machine Company
Weckesser Company
West Instrument Company
Wheelco Div., Barber-Colman Co.
Wollensak Optical Co.
Zenith Electric Company

(as of July 18, 1955)

YOU WILL SEE

A COMPLETE DISPLAY OF AUTOMATION PRODUCTS

Analog-to-digital converters
Analytical control equipment
Automatic assembly equipment
Automatic circuit testers
Automatic control valves
Automatic control systems
Automatic controllers for temperature, pressure, flow, liquid level, time, gas analysis, etc.
Automatic feeding devices
Automatic gaging equipment
Automatic handling equipment
Automatic inspection devices
Automatic machine controls
Automatic packaging equipment
Automatic tabulators
Automatic tape controls
Automatic voltage regulators
Brakes, clutches, and drive mechanisms
Cameras, high-speed
Capacitors
Coded keyboards
Combustion controllers
Communication systems including closed circuit television, telephone and paging systems
Compressors/automation air
Computers, analog or digital
Computer components
Continuous analyzers
Continuous testers
Conveyors
Counters, circuit controlling
Counters, high speed
Current and frequency regulators
Data processing and data reduction systems
Data transmission and computing systems
Decade counters
Digital voltmeters
Electric motors
Electronic business machines
Electronic computers
Electronic control devices
Electronic, electrical, mechanical components for automatic production systems
Feedwater control systems
Frequency converters
Indexing machines
Industrial television, closed circuit
Instrumentation/automation panels and cubicles
Instruments for measurement and control
Limit stops
Limit switches
Machine tool controls
Magnetic amplifiers
Magnetic equipment, non-electric
Magnetic-tape controlled machines
Magnetic-tape recorders for storage, programming, automatic tools, processes
Metering equipment
Microscopes
Missile test systems
Monitoring systems
Motor controls
Optical gages and inspection devices
Oscillographs
Packaged servo systems
pH controllers
Photoelectric control devices
Photomicrographic equipment
Physical testing equipment
Positioning equipment
Potentiometers
Power supplies
Printed code readers
Process timers
Radioactivity equipment
Scales
Scanning systems
Servo-components
Servomechanisms
Shaft position synchros
Signalling equipment
Smoke controls and alarms
Solenoid valves
Speed controls
Strain measuring devices for automatic controls
Stroboscopes
Switches, relays and other electrical components
Telemetering systems
Teleprinters and facsimile
Timers
Transducers
Transformers
Two-way radio
Valves
Vibration control equipment
Weighing and proportioning equipment
Work positioning mechanisms
X-ray, flouroscopic devices
X-ray gages

YOU MAY STOP AT THESE HOTELS

ATLANTIC
BELAIR
DEL PRADO
EDGEWATER BEACH
HAMILTON
HARRISON
KNICKERBOCKER
MARYLAND
NEW LAWRENCE
NORTH PARK
PLAZA
ROSEMOOR
ST. CLAIR
SHERIDAN PLAZA
SHERRY
SHORELAND

Write early for reservations . . .
Mention the 2nd International Automation Exposition

YOU CAN REACH THE NAVY PIER BY

BUS: Marked "Automation Exposition" from the major loop hotels. There is no charge.

AUTOMOBILE OR TAXI: Take Lake Shore Drive north to Grand Avenue, and turn right to the Pier.

(OVER)

REGISTRATION

This is your registration card and badge. It is intended to speed your entry into the show.

DO NOT MAIL

See instruction reverse side.

SHOW HOURS

2:00 to 10:00 P.M. DAILY
Monday Through Thursday
NOVEMBER 14-17, 1955

THE EXPOSITION MANAGEMENT

invites you to attend the "Show of the Future"

Everyone is interested in automation. This exposition is the ONLY industrial show that attracts the leaders of finance, national news services, educational institutions, and research organizations—as well as top men in industry and engineering. This is why the Automation Exposition is the "show of the future."

CHICAGO
NOV. 14-17
1955

This is YOUR TICKET to the
- show of the future -

the 2nd INTERNATIONAL AUTOMATION EXPOSITION

CHICAGO NAVY PIER
NOVEMBER 14-17, 1955

The time is right—same week as 75th Anniversary meeting of the American Society of Mechanical Engineers in Chicago.

The place is perfect—Chicago's Navy Pier is ideal, spacious and convenient.

The theme is hot—every important executive and engineer is "automation" conscious—on the lookout for better and faster ways to control production, quality, and costs.

To find the answers to the problems of tomorrow, visit the "show of the future"—TO REGISTER (no fee) . . . just tear off the ticket above . . . fill it in completely . . . USE TYPEWRITER . . . or letter legibly . . . no other registration required . . . bring ticket to the show with you—DO NOT MAIL . . . for additional tickets and information, write to:

EXPOSITION MANAGEMENT, Richard Rimbach Associates, Inc.
845 Ridge Avenue, Pittsburgh 12, Pa. — *at no charge or obligation*

ADVANCE REGISTRATION

Fill in card and stub COMPLETELY. Use TYPEWRITER or print LEGIBLY. Bring it to Advance Registration Desk at the Exposition . . . DO NOT MAIL THIS CARD.

Your Name .....

Title .....

Company Name .....

Co. Address (STREET) .....

City ..... Zone ..... State .....

Company's Business or Product .....

Your Hotel .....

Use TYPEWRITER or print legibly. DO NOT DETACH.

Name .....

Title .....

Company .....

City ..... State .....

2nd International Automation Exposition

Tear out ticket along the dotted line. Properly filled in, it will admit you to the Second International Automation Exposition. No other registration is required. For additional tickets, write to the Exposition Management, Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 12, Pa. There is no charge or obligation.

HOW CAN YOU APPLY AUTOMATION TO YOUR PRODUCTION PROCESSES?

The Second International Automation Exposition has been designed to give a concentrated picture of the potentialities and the new techniques and new equipment available for instrumentation and automation.

The Automation Exposition . . . the automatic production show . . . will have all of the products and components which comprise automation for industry and research.

More than 130 exhibitors — all of them top companies—represent a vast range of equipment and services for instrumentation and automation: automation control systems; highly automatic machine tools; digital and analog computers; automatic inspection devices; conveyors; communication systems, including closed-circuit television; feeding devices; work positioning mechanisms; and electronic, electrical and mechanical components which go to make up automatic production systems.

THREE CLINICS (pre-registration required) PRESENT THE LATEST THOUGHT AND PRACTICE IN THE APPLICATIONS OF:

Electronic Computers
Conveyor Automation
Laboratory Automation

2nd INTERNATIONAL AUTOMATION EXPOSITION

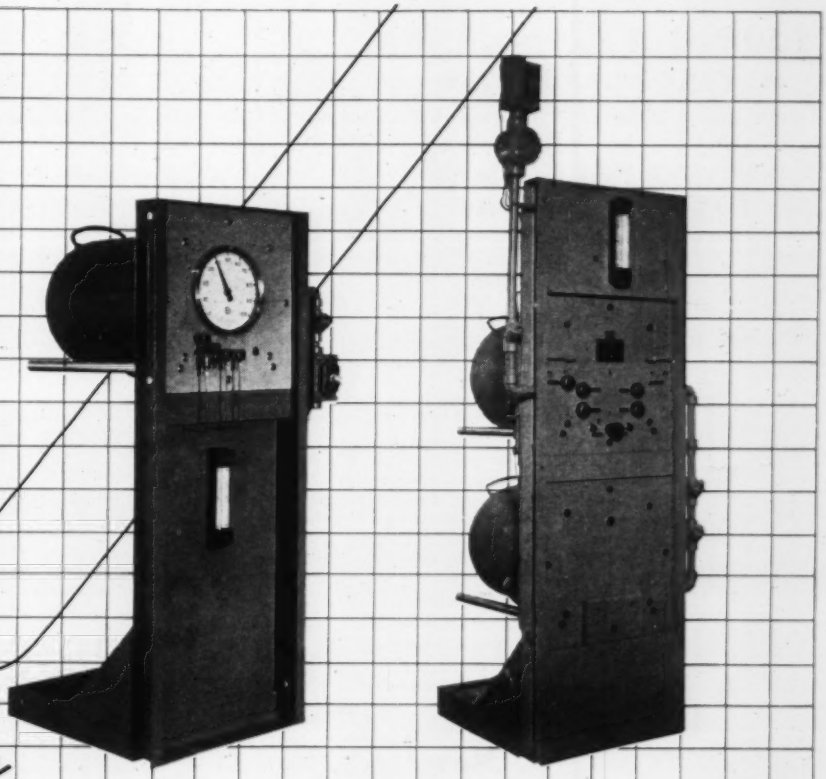
The Navy Pier, Chicago, November 14-17, 1955

Copyright 1955—Printed in U.S.A.

throughput up

quality up

costs down



process refractometer

(Type 38-201)

Monitors or automatically controls a process stream by *continuously* comparing its refractive index (the measure of the velocity of light through the test fluid compared to its velocity through a vacuum) with the index of a sample of *desired* composition. SEND FOR BULLETIN CEC 1839-X9.

infrared analyzer

(Type 38-101)

Handles up to five streams at a rate of 5 analyses per hour, i.e., 12-minute cycle. Increases fractionator capacity by minimizing fluctuations and holding product composition steady. Eliminates the time lag inherent in sampling and batch analysis. SEND FOR BULLETIN CEC 1840-X9.

Here are the first "Consolidated-Phillips" *continuous* process analyzers . . . units which provide analytical data while it's valid, *before* variables have changed. With these two instruments on stream, product quality and production go up . . . costs go down. You can install and maintain them for less, on an hourly basis, than a laboratory technician's salary. Both instruments are completely explosion- and weather-proof.

Consolidated-Phillips process analyzers have been proving their ability . . . and dependability . . . under actual plant conditions for several years. Originally designed and formerly manufactured by Phillips Petroleum Company, they are now backed by Consolidated Engineering's nationwide service organization . . . assurance of interruption-free operation for years to come at the pace demanded by modern refinery practice.

Whether your process instrumentation needs are for a single unit or a complete analysis-and-control system, you'll find it will pay to talk to a CEC Field Engineer. Write us today.

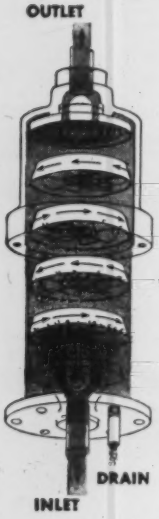
Consolidated Engineering
Corporation

ELECTRONIC INSTRUMENTS
FOR MEASUREMENT AND CONTROL
300 North Sierra Madre Villa,
Pasadena 15, California

Sales and Service Offices Located in: Albuquerque, Atlanta, Boston, Buffalo, Chicago, Dallas, Detroit, New York, Pasadena, Philadelphia, San Francisco, Seattle, Washington, D.C.

For more information circle **33** on inquiry card.

EQUIPMENT LASTS LONGER
...PERFORMS BETTER...
when the
ARIDIFIER
SCRUBS, CLEANS AND DRIES
On Air and Gas Lines

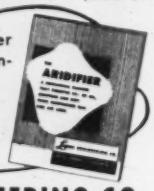


LASTS LONGER because...
The Aridifier's patented centrifugal-baffle action traps 92% of all dirt, oil, scale and water in gas or compressed air . . . and drains off these troublemakers *before* they can damage tools and equipment.

PERFORMS BETTER because...
The Aridifier protects tools against the freezing, fouling, caking and corrosion caused by dirt and foreign matter . . . assures the clean, dry air and gas that means better spray work, painting, lacquering, sand blasting, air cleaning, and similar operations.

Easily installed, the Aridifier maintains itself. 10 models. Capacity range; 7 CFM to 17,000 CFM.

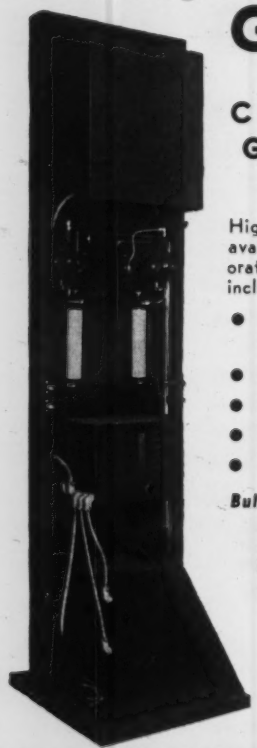
Learn HOW the Aridifier scrubs with a patented centrifugal-baffle action.
Write for This Catalog Now!



Logan ENGINEERING CO.
4921 W. Lawrence Ave., Chicago 30, Ill.

For more information circle **34** on inquiry card.

For Recording, Indicating, and Controlling
GOW-MAC
THERMAL CONDUCTIVITY GAS ANALYSIS APPARATUS



High accuracy, low cost instruments available for plant streams and laboratories. Recommended applications include—

- GAS CHROMATOGRAPHY
- GAS MIXING
- GAS PURITY
- PROCESS CONTROL
- TRACE IMPURITY

Bulletins available on
PANEL INSTRUMENTS
SENSING ELEMENTS
PORTABLE INSTRUMENTS

Write Dept. I for complete data or visit:
BOOTH A-268
10th ANNUAL INSTRUMENT CONFERENCE
SHRINE AUDITORIUM
Los Angeles, Sept. 12 to 16

GOW-MAC INSTRUMENT CO.
100 KINGS ROAD, MADISON, N. J.

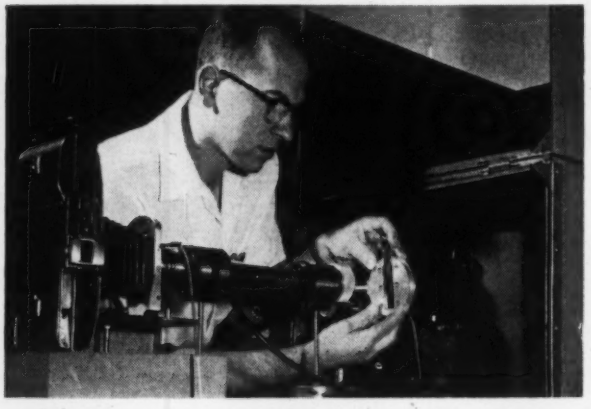
For more information circle **35** on inquiry card.

NEWS—CONTINUED

Allen B. Du Mont Laboratories, Inc., Clifton, N. J., under a licensing agreement recently concluded between Socony-Vacuum and Du Mont. Oscilloscope patterns of 65 different engine ailments (ignition, timing, valves, etc.) have been observed and identified.

"Snooperscope"

SCHENECTADY, N. Y.—The "Snooperscope" (a product of Great Britain) is used here by Dr. William C. Dash, staff physicist at the GE Research Lab, Schenectady, to examine crystals of pure silicon by infrared. The source



of illumination is an incandescent lamp, but of the total illumination only the invisible infrared radiation passes through and is changed to visible light by the 'scope, thus disclosing structural information. The "snooperscope," a war-time development used for nocturnal observations via infrared emissions, shows promise as a basic industrial tool. For example, Dr. Dash reports that he can study the interior of silicon sections microscopically, in polarized light.

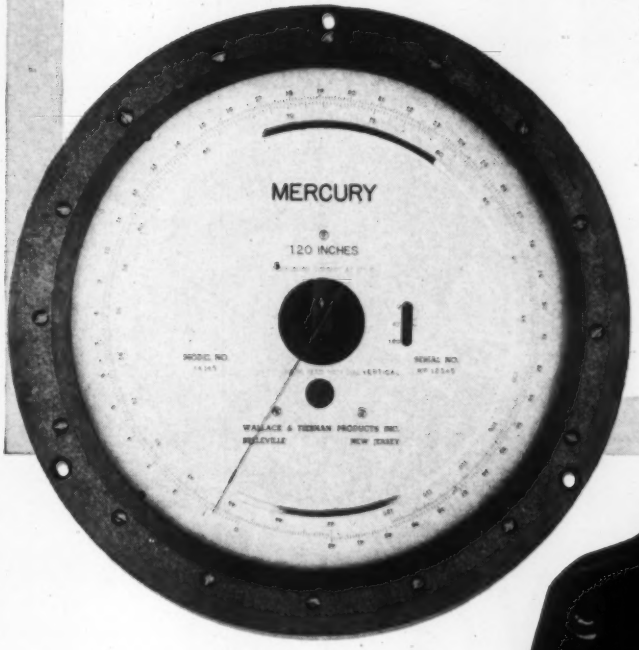
Automatic Inspection

DETROIT, MICH.—In approximately 16 feet of straight-line "automated space," all materials handling, mechanical inspection, and magnetic testing functions for speaker magnets, previously done in a 50-square foot area, are centralized in two new electronically-controlled machines installed recently in the Edmore, Mich., permanent-magnet plant of Carboloy Department of General Electric Company. The *mechanical inspection unit* processes 2100 speaker magnets per hour (three times faster than manual inspection), inspects visually for defects, then automatically checks the magnets for length, outside

PRECISION PRESSURE MEASUREMENT

of Gauge Pressure, Vacuum or Differential Pressure

Precision Dial Manometer Type FA-145



Accuracy:
1 part in 1000 over full scale.
Sensitivity:
1 part in 10,000 in *all* ranges.
Ranges:
0 to 120 inches of water (min.)
0 to 250 inches of mercury (max.)
Other intermediate ranges available.
Scale Length:
45 inches.
Dial Diameter:
8½ inches.

Precision Low Pressure Gauge Type FA-141

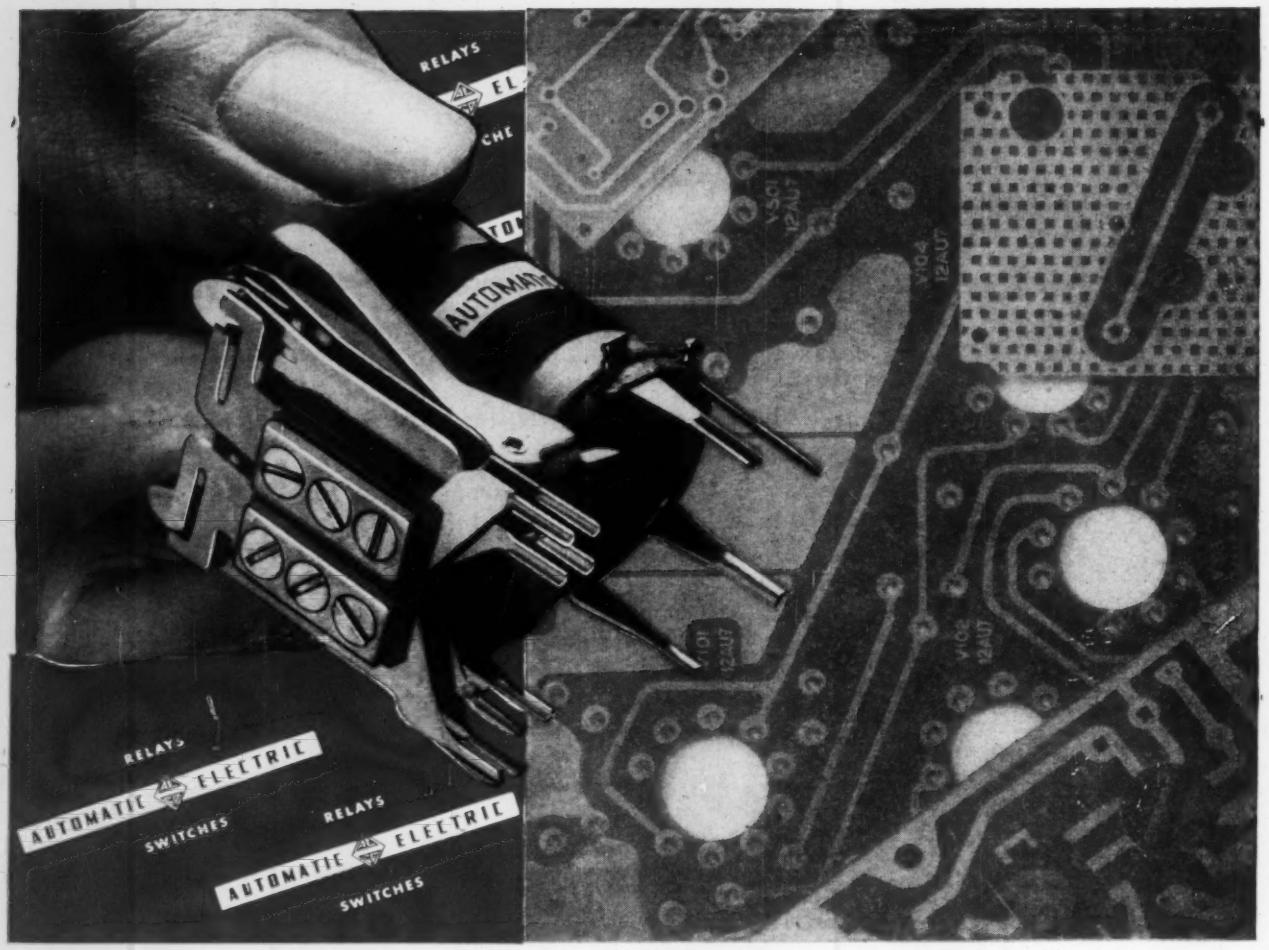
Accuracy:
1 part in 300 over full scale.
Sensitivity:
1 part in 500 in *all* ranges.
Ranges:
0 to 10 inches of water (min.)
0 to 400 inches of water (max.)
Other intermediate ranges available.
Scale Length:
7 or 16 inches.
Dial Diameter:
2¾ or 6 inches.

WALLACE & TIERNAN
INCORPORATED
PRECISION INSTRUMENTS AND ELECTRICAL MECHANISMS
25 MAIN ST., BELLEVILLE 9, N. J.
In Canada: Wallace & Tiernan, Ltd., Toronto

For additional data, write for Publication TP-30-A and TP-27-A

A-101

For more information circle **36** on inquiry card.



NOW!

dependable relays for printed circuits

Maybe you, too, have been awaiting availability of a *good* relay for direct insertion into printed circuits. Now Automatic Electric can solve your problem with a miniature relay that is just right.

120 million operations, without a single readjustment or relubrication! That's what you get from this rugged, improved Series SQD Relay, because it features a special *heavy-duty* bearing and bearing pin. Also a recess in the bearing plate retains an adequate supply of lubricant for long-term lubrication of the bearing pin.

Consider these additional advantages:

1. The sections of the terminals that insert into the printed circuit board are NOT brazed or welded into place, but are integral parts of the coil terminals and contact springs—thus preventing internal loss in conductivity or continuity.
2. Terminal design permits direct plug-in of the relay into a printed circuit board, ready to be secured in place with any acceptable soldering technique.

Usually the desired contact spring combination, or pile-up, is sufficiently large so that additional mounting (support) of the relay is not necessary.

SQD Miniature Printed Circuit Relays are available with many different contact spring arrangements, and for a multitude of applications. Springs can be made of phosphor-bronze, "Bronco" metal, or other special-purpose materials, as required.

Of course the long life, heavy-duty features of the improved SQD Relay can be had in the conventional type of plug-in relay, if regular sockets are preferred for use, whether in printed circuitry or other applications.

To get complete details, write: Automatic Electric Sales Corporation, 1033 West Van Buren St., Chicago 7, Illinois. *In Canada:* Automatic Electric (Canada) Ltd., Toronto. *Offices in principal cities.*

RELAYS SWITCHES

PRODUCTS OF THE INDUSTRIAL DEPARTMENT OF

AUTOMATIC ELECTRIC

CHICAGO

For more information circle **37** on inquiry card.

diameter, end-squareness and parallelism. Following this is the *electronically-controlled magnetic testing unit*, which processes about 1600 speaker magnets per hour, and tests the magnetic output of individual magnets.

SWAC

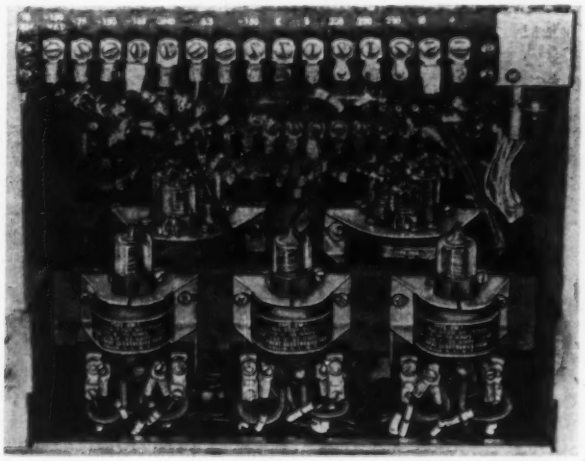
WASHINGTON, D. C.—The scope and complexity of problems that can be handled by SWAC (National Bureau of Standards Western Automatic Computer) has been extended by use of an auxiliary magnetic-drum memory. Directly behind the operating console (center foreground) is the Williams memory consisting of a bank of 37 cathode-ray tubes. On either side of the Williams memory are cabinets containing the control unit. Other cabinets in the left

background contain the magnetic drum auxiliary memory and its control circuitry. In front of the magnetic drum is the punched-card input-output system, and on the right of the console is a paper-tape input unit.

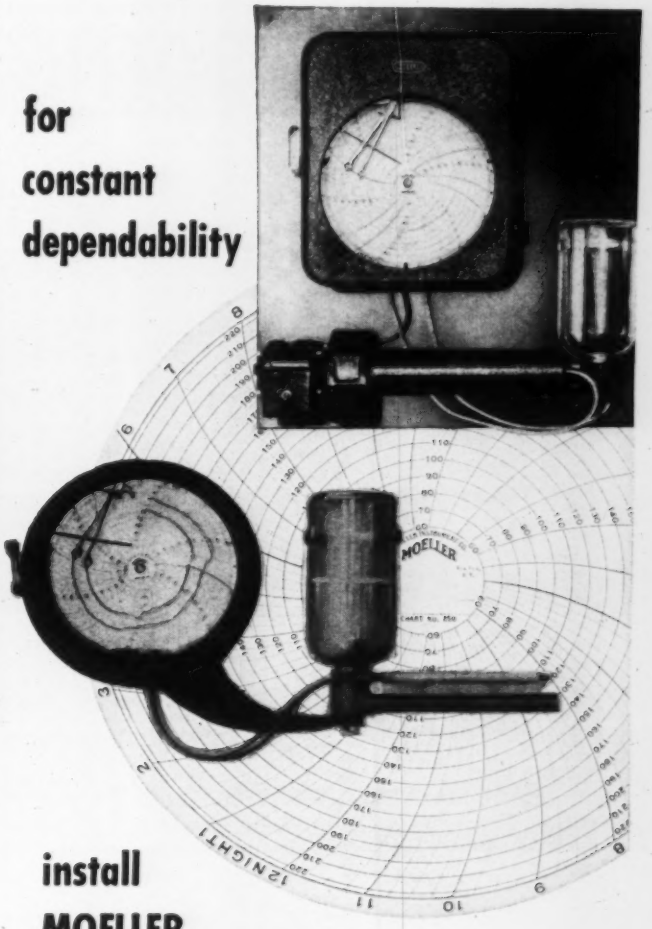
SWAC's operating console is provided with oscilloscope screens for viewing the memory pattern and with neon lights to indicate what is taking place inside the machine.

Univac Uses Ebert Relays

NEW YORK, N. Y.—In the design of the Univac 120 punched-card Electronic Computer, Remington Rand's Laboratory of Advanced Research selected for power control the mercury plunger relays manufactured by Ebert Elec-



tronics Corp., Queens Village 28, N. Y. Univac 120 Computer designers and engineers chose two types of Ebert Relays for use in the Univac 120: two model EM-7 three-pole relays control the main power circuits, and three model EM-1 single-pole units handle the various primary circuits of heater and d-c. supplies which are switched on in proper sequence by means of a timer.



for constant dependability

install MOELLER recording

PSYCHROMETERS

Industry and commerce rely upon Moeller Recording Psychrometers (wet and dry bulb temperature type) for humidity determinations and records. Correctly designed and dependable in every detail, these improved, streamlined recording psychrometers offer the best in craftsmanship.

Reliability has been an outstanding feature of Moeller Products since 1867.

MOELLER INSTRUMENT COMPANY
132nd ST. and 89th AVE
RICHMOND HILL 18, N. Y.
Representatives in Principal Cities

Gentlemen: Without obligation, please send me Catalog No. 150 on Moeller Recording Psychometers.

NAME .....

FIRM .....

ADDRESS .....

CITY ..... ZONE ..... STATE .....

For more information circle **38** on inquiry card.

MARSHALLTOWN

DIAPHRAGM GAUGE

For Accurate Pressure Measurement in Ounces or Inches of Water

Available in standard dials (reading in inches of water) 0-15" -0-30" -0-60" -0-100" 0-160" . . . also in ounce graduated dials from 15 ounces to 5 pounds. 2½", 3½" and 4½" dial sizes mounted in black enameled steel case.

Marshalltown Figure 83 is an extremely sensitive gauge that uses a carefully seasoned bronze diaphragm to accurately measure very low pressures. It is used extensively on many types of natural gas installations for checking low pressures.

Write for details and price. LOOK TO MARSHALLTOWN FOR ONE OF THE MOST COMPLETE LINES OF INDICATING PRESSURE GAUGES MADE!

MARSHALLTOWN MANUFACTURING CO.
MARSHALLTOWN 3, IOWA

For more information circle **39** on inquiry card.

A two-position, 4-way valve for air or hydraulic fluids at pressures to 100 psi and vacuum to 25".

FEATURES:

Leak free operation. Low cost. Low handle torque. Low pressure drop. Easy panel mounting. Corrosion-resistant materials—bronze, aluminum. Simple maintenance—disassembly without disconnecting lines.

SPECIFICATIONS:

1. Fittings—Model S-576 for ¼" tubing port connections per AND10056. Model S-576-1 for ⅜" female pipe thread port connections.
2. Weight 6 ounces.
3. Seals—standard commercial "O" rings.
4. Finish—black anodized.
5. Size: 3¾" wide by 2¾" deep, including handle.

For complete information, send for Bulletin 3000.

SPRAGUE *Engineering Corporation*

1144 WEST 135TH STREET, GARDENA, CALIFORNIA

For more information circle **40** on inquiry card.

Books...

INSTRUMENTS and AUTOMATION

The Automatic Factory—A Critical Examination. By Stephen A. June, John D. Bardis, Lee H. Lurio, Leonard S. Polaner, Oystein Sagedahl, Herbert A. Sklenar, Bernard K. Yenkin. Cloth, 88 pages, 5¼ x 8¼ inches. The Instruments Publishing Company, Pittsburgh 12, Penna. $1.50 postpaid.

This is a joint report by seven candidates for the degree of Master of Business Administration. It is the result of their travels and investigations during six months. Here at last is an unslanted story—a factual report crammed full of case studies with company names. This report attempts to bridge the gap between the theoretical concepts and the actual industrial developments of the Automatic Factory. It has been written principally for the American businessman in an attempt to clarify and expose the sometimes hypothetical and imaginative writings of scientific and commercial authors. Dreaming and guesswork have been purposely omitted and those interested in that type of analysis are referred to the 'science-fiction' writers. Realism and practicality are the foundation of this report.

Electronics Test Equipment Descriptive Data Sheets, three volumes, loose-leaf hard-bound, 1955, published by Carl L. Fredrick and Associates, Bethesda, Md. $100. 10 x 11½ in. Has over 2300 pages covering almost 900 separate test equipments. Includes nomenclature index, commercial index, and cross-reference by designation and functional classification.

Analysis of Feedback Control Systems, Servomechanisms and Automatic Regulators, by Robert A. Bruns and Robert M. Saunders. 1955. McGraw-Hill Book Co., New York 36, N. Y. 383 p. $7.50. 9¼ in. Presents a unified method of analysis consistent with the technological background of the average person new to the field.

Computer Development (SEAC and DYSEAC) at the National Bureau of Standards, Washington, D. C. 1955. National Bureau of Standards. U. S. Government Printing Office, Washington 25, D. C. 146 p. $2. 10½ in. (Circular 551.) Reviews the Bureau's work with electronic computers, dealing with design, construction, operation and maintenance of computer equipment.

Diagrams in Punched Card Computing, by Fred Gruenberger, 1954. Univ. of Wisconsin Press, Madison 5, Wis. 139 p., unbound. $3.75. 11 in. Intended primarily as an aid to universities, but useful also to industrial installations. Pre-supposes familiarity with author's "Computing Manual."

Linearized Theory of Steady High-speed Flow, by G. N. Ward. 1955. Cambridge Univ. Press, Bentley House, London N.W. 1, England. 243 p. $6. 8¾ in. Claims to be "the first permanent work devoted to the problems involved in this important and rapidly developing subject, and to the mathematical and physical assumptions on which the theory is based."

Outline of Atomic Physics, by Oswald H. Blackwood, Thomas H. Osgood and Arthur E. Ruark. [c1955.] John Wiley & Sons, New York 16, N. Y. 501 p. $7.50. 9¼ in. For readers who have an elementary knowledge of physics, it is designed to show what physical science has to say about the structure of atoms and molecules and the nature of radiation.

BORG MICROPOTS

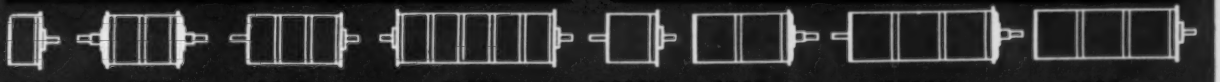
Model 9235S

the NEW STANDARD of precision multi-turn potentiometers

BORG 900 SERIES 3-TURN AND 10-TURN MICROPOTS

3-TURN MODELS 931-935

10-TURN MODELS 901-903



9315 9328S 9335K 9355S 9015K 9028 9038K 9035

Standard models of Borg 900 Series Micropots offer such flexibility that they meet special design needs. Borg has created a new standard for high-precision, multi-turn potentiometers.

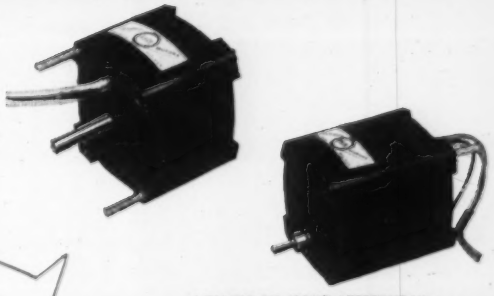
Advantages of the Borg 900 Series include greater accuracy, finer resolution, lower torque, longer life, better performance under severe and excessive vibration, greater adaptability and versatility of application.

Standard models include: 10-turn precision Micropots in 1 to 3 gang models, 3-turn in 1 to 5 gang models, single or double shafts, servo or bushing mounts on either or both ends. Available to designers and engineers in any quantity.

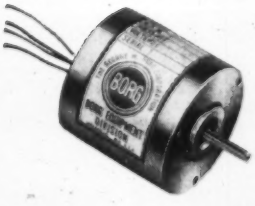
SYNCHRONOUS AND INDUCTION BORG-MOTORS

1000 SERIES 2 POLE AND 4 POLE MODELS
With and Without Gear Trains

These Borg-Motors were designed specifically for instrumentation, control and timing devices. They are recommended for all applications where low torque, constant speed and long life are positive requirements.



For Complete Engineering Data



SERVO-CONTROL
Borg-Motors

Two phase, 115 volt, 400 cps induction type Borg-Motors for servo control applications. Approximate size 1½" diameter x 2" long with a locked rotor torque of 0.82 ounce-inch.

ATTACH TO YOUR LETTERHEAD

BORG EQUIPMENT DIVISION
THE GEORGE W. BORG CORPORATION
JANESVILLE, WISCONSIN

NAME.....

TITLE.....

Please send complete information and engineering data on items checked.

- ☐ Precision Multi-Turn Potentiometers, 900 Series
- ☐ Borg Standard Potentiometer, 1100 Series
- ☐ Precision Multi-Turn Counting Dials
- ☐ Servo Control Motors
- ☐ Frequency Standards
- ☐ Instrument Motors
- ☐ Contract Manufacturing

BORG EQUIPMENT DIVISION

THE GEORGE W. BORG CORPORATION

JANESVILLE, WISCONSIN

For more information circle **41** on inquiry card.

NEW! ASHCROFT 2½" GAUGE

HAS TYPE 316 STAINLESS STEEL SYSTEM TO WITHSTAND CORROSIVE CONDITIONS

High resistance to corrosion and sustained high accuracy are combined in this new heavy-duty Ashcroft Gauge. The 2½" dial size makes this compact instrument ideal for small tanks and processing equipment where large pressure gauges would be impractical. Bourdon tube (welded at socket and tip) . . . square shank and ¼" male N.P.T. bottom connection . . . geared movement—the entire gauge system is Type 316 stainless steel.

Made in standard graduations from 30 psi through 1,000 psi, this new Ashcroft Pressure Gauge has a black dial with easy-to-read white figures. The drawn steel case and threaded ring are finished in black. Pointer is precision needle type. Every part is designed, tested and manufactured to meet rigid service conditions.

YOUR INDUSTRIAL SUPPLY DISTRIBUTOR now has this new Ashcroft Gauge in stock. Let him know your requirements. You can depend on him for experienced counsel and prompt delivery.

In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

1850 ASHCROFT U.S.A.

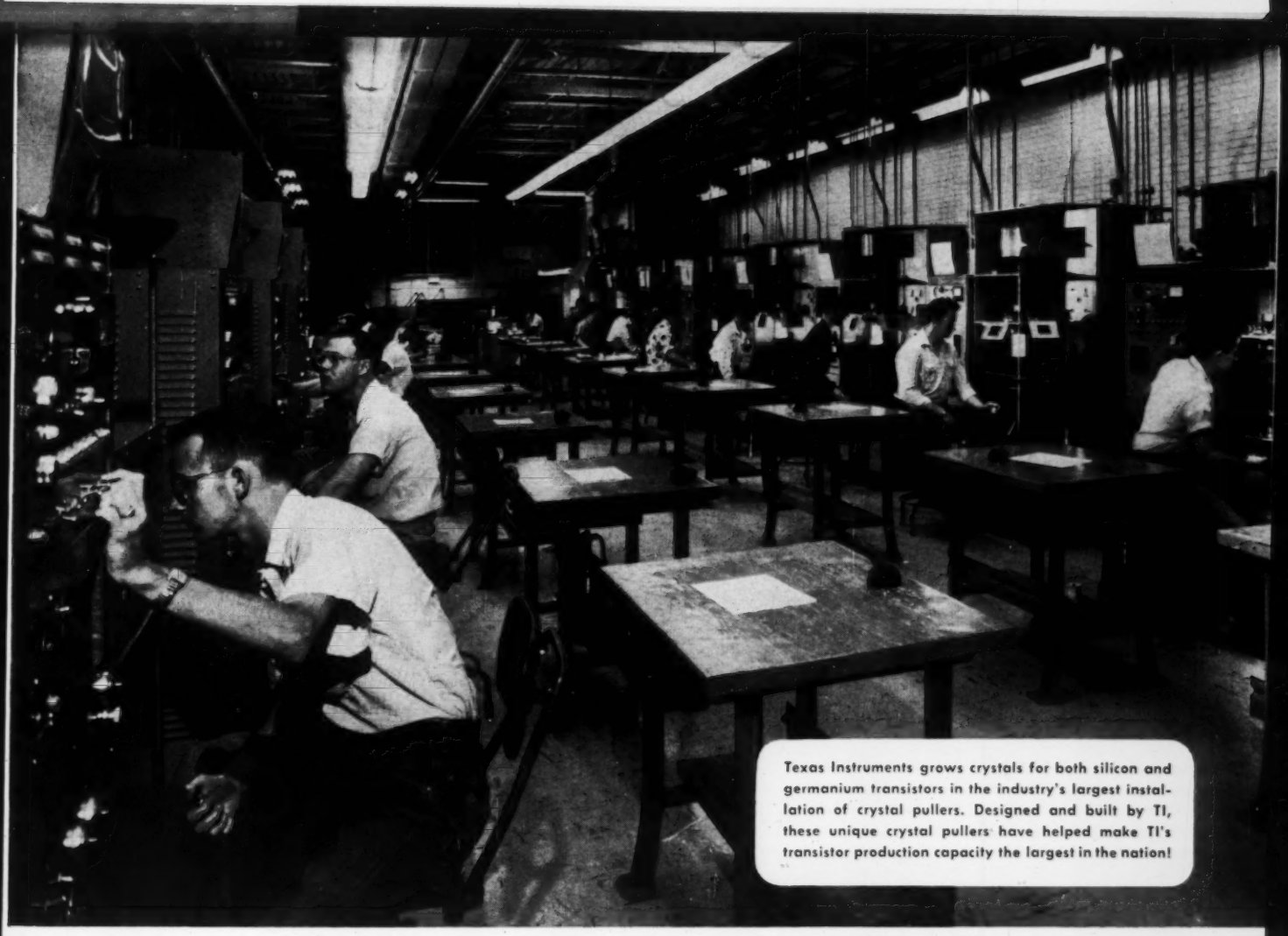
ASHCROFT GAUGES

MAXWELL MANNING & MOORE INC. TRADE MARK

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

For more information circle **42** on inquiry card.



Texas Instruments grows crystals for both silicon and germanium transistors in the industry's largest installation of crystal pullers. Designed and built by TI, these unique crystal pullers have helped make TI's transistor production capacity the largest in the nation!

ORDER FROM THE WIDEST LINE OF SEMICONDUCTOR DEVICES

GERMANIUM RADIO TRANSISTORS

SILICON TRANSISTORS

SILICON POWER TRANSISTORS

SILICON JUNCTION DIODES

N-P-N AND P-N-P GENERAL PURPOSE TRANSISTORS

PHOTOTRANSISTORS

GROWN JUNCTION TETRODES

HIGH SPEED SWITCHING TRANSISTORS

WRITE FOR LITERATURE

TI mass production means transistors today . . . not "available soon"

You get immediate delivery . . . in the quantity you need . . . when you order transistors from Texas Instruments. Mass production methods mean *no waiting* for silicon or germanium transistors . . . and at low prices! Only from TI can you get high temperature silicon transistors. Only from TI can you get *product-proved* germanium radio transistors. With the industry's largest transistor production capacity, TI can meet your delivery requirements – whether you need radio-type transistors by the hundreds or hundreds of thousands!

Texas Instruments low cost germanium radio transistors are used in the *first* transistorized consumer product – a high performance pocket radio on sale across the nation. High temperature silicon transistors (stable to 150° C), produced only by TI, are already being used in important military and commercial applications.

Each TI semiconductor product is glass-to-metal hermetically sealed . . . thoroughly aged and tested . . . to assure successful performance and long range reliability. The nation's leading manufacturer of transistors, Texas Instruments is your most experienced source for semiconductor products.

TWENTY-FIFTH YEAR OF PLANNED GROWTH

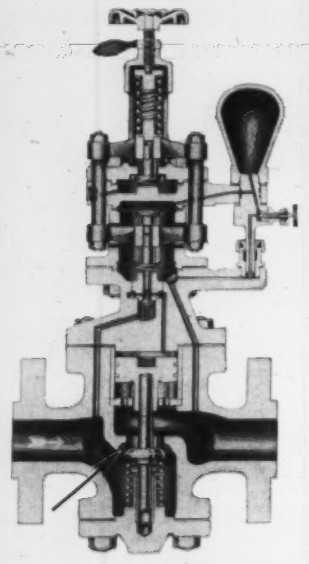
TEXAS INSTRUMENTS
INCORPORATED
6000 LEMMON AVENUE DALLAS 9, TEXAS

★ *See our exhibit at the Wescon Show*

For more information circle **43** on inquiry card.

STELLITE'S *IN* EROSION'S *OUT*

No Erosion Here!



Arrow shows location of integral stellited seating surface in Leslie Pump Pressure Regulator.

Stellite as a *standard* seating surface for regulators and control valves in steam service is a Leslie exclusive. Combined with a hardened stainless steel main valve, stellite provides the most erosion resistant combination known, and is available in integral and renewable seating arrangements.

This unbeatable combination, pioneered in the field by Leslie, is the product of many years' experience and knowledge of proper stelliting and heat treating techniques. And with Leslie, it's *standard* in a wide range of regulators and control valves designed to meet any temperature or pressure requirements.

When erosion and wear are factors to consider, it will pay you to call your Leslie engineer to demonstrate how, with Leslie equipment, "Stellite's In — Erosion's Out".

TRADE LESLIE MARK

Write for Bulletin 552
"When To Use A Controller And When To Use A Regulator".

REGULATORS AND CONTROLLERS

LESLIE CO., 299 GRANT AVENUE, LYNDHURST, NEW JERSEY

3572

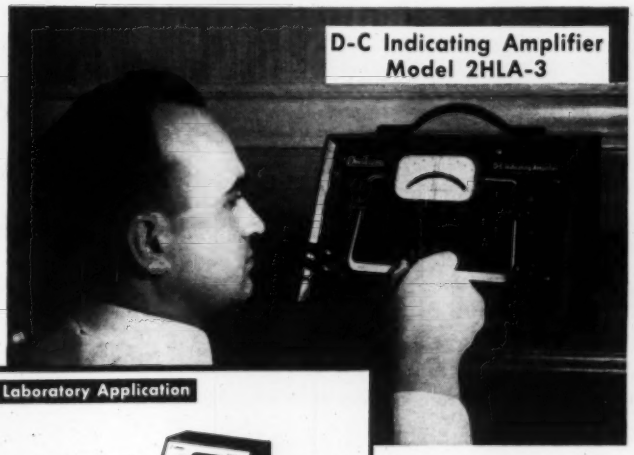
CONTROLLED QUALITY MEANS QUALITY CONTROLS

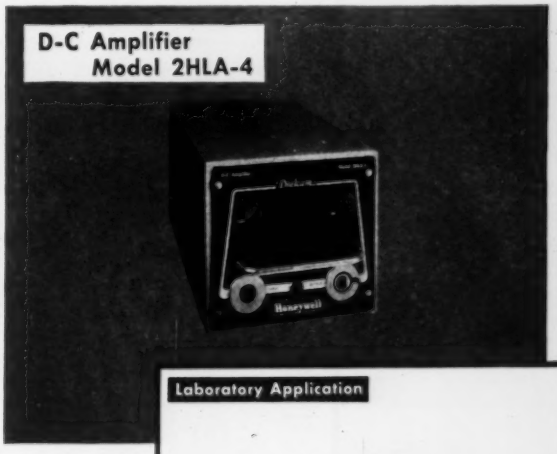
For more information circle **44** on inquiry card.

NEW DOELCAM PROPORTIONAL AMPLIFIERS OFFER GREATEST VERSATILITY IN LOW LEVEL D-C SIGNAL APPLICATIONS

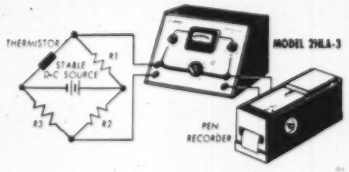
HERE ARE TWO PRECISION AMPLIFIERS incorporating the new *Doelcam Second Harmonic Magnetic Converter* as the input stage. This unique design concept makes possible low noise level, high sensitivity and linear output.

The Model 2HLA-3 is both a Linear Indicator and a Multirange Amplifier. The Model 2HLA-4 is a Single Range Amplifier with provision for interchanging range by plug-in units. Both are ideal for either laboratory or production use.



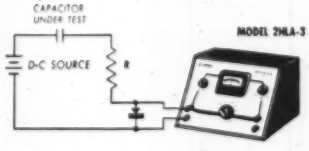


Laboratory Application



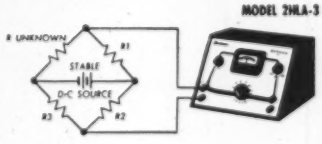
The fast thermal response of highly sensitive thermistors can be accurately measured and recorded.

Production Application



Measuring the dielectric leakage current of capacitors.

Production Application



Production testing of precision resistors or potentiometers in a balanced bridge circuit.

Write for Bulletin 1A-4 Write for Bulletin SRA-4

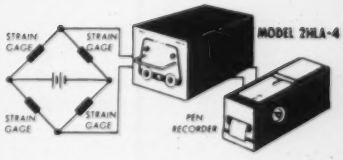
WHETHER YOUR APPLICATION is in the laboratory or on the production line, one of these two instruments is ideally suited. Their versatility is illustrated in the diagrams shown here. The Model 2HLA-3 is both a precision measuring laboratory instrument and a rugged production test instrument. The Model 2HLA-4 is designed for rack mounting as a component part of a control or measuring system.

HERE ARE SOME PERFORMANCE CHARACTERISTICS:

- High Gain — 10^4 for 2HLA-3, 10^5 for 2HLA-4
- Low Noise — less than 5 microvolts equivalent input
- Linear Amplification—better than ± 1% on all ranges
- High Stability — zero drift less than 10 microvolts
- Rugged — withstands inputs of 1.5 volts

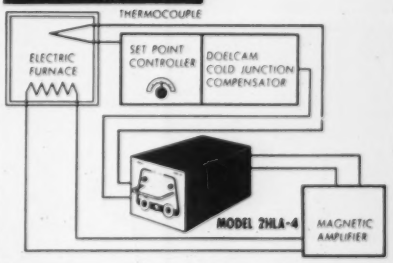
SPECIAL APPLICATIONS: These instruments can be easily adapted to provide linearity down to 0.1%, isolated input, multiple inputs, increased gain, increased power output and extended frequency response. Send us your complete requirements.

Laboratory Application



Dynamic stress measurements made with linear response up to 20 cps.

Control Application



Temperature control within a small temperature range.

Doelcam

A DIVISION OF MINNEAPOLIS-HONEYWELL

H HONEYWELL

SOLDIERS FIELD ROAD
BOSTON 35, MASS.

Instruments for Measurement and Control

Synchros • Gyros • Amplifiers • Microsyns • Servo Motors

For more information circle **45** on inquiry card.

Designed for one...

In 1816, Eliphalet Remington was dissatisfied with the old inaccurate squirrel gun, which consistently spoiled his attempts to win a shooting match. He determined to build a gun which would meet the specific needs of precision marksmanship. The weapon he produced achieved such remarkable results that the ensuing demand for similar models created a great industry.

...SOUGHT BY MANY

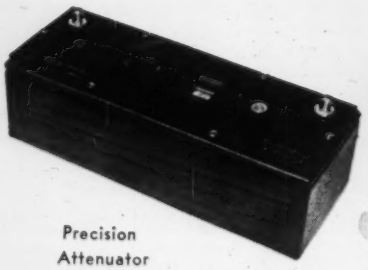
Seeking to overcome the deficiencies in many of today's standard electronic devices, engineers at Airborne Instruments Laboratory created the devices shown here. Though developed for use at AIL, their adaptability for many applications has resulted in a wide demand by manufacturers and users of electronic equipment. Thus, production and sales have become important areas of operations at Airborne.

Visit us in Booth 1406, 1955 WESCON, August 24, 25 and 26 or send for complete information.

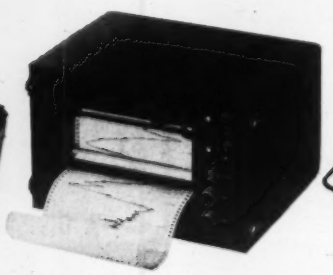
AIRBORNE INSTRUMENTS LABORATORY
INCORPORATED

160 OLD COUNTRY ROAD • MINEOLA, NEW YORK

Polar Pattern Recording Systems



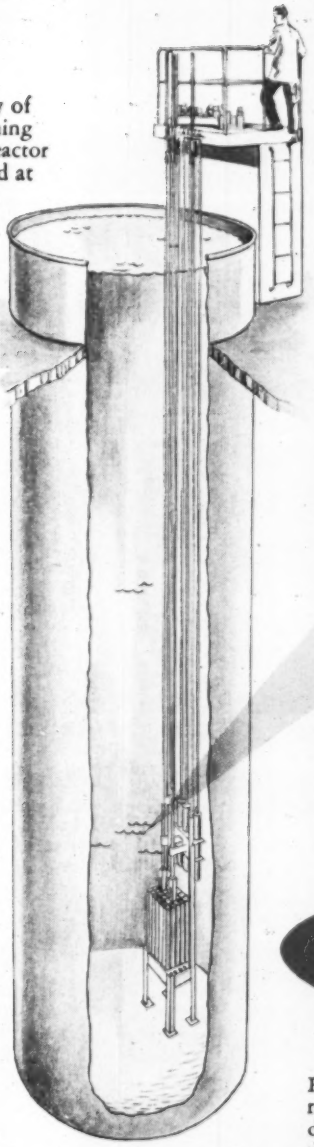
Precision Attenuator



Rectangular Coordinate Recording System

Microwave Crystal Test Set

For more information circle **46** on inquiry card.



Cutaway of "swimming pool" reactor exhibited at Geneva.

Panellit is proud to have contributed to the Atoms-for-Peace Conference

Control panel built for nuclear reactor includes unique graphic indicator that simulates movement of control rods in reactor

Oak Ridge National Laboratory specified a precise and safe control system for Project Aquarium—the "swimming pool" reactor built for display to 1200 scientific delegates at the Geneva Atoms-for-Peace Conference.

Requirements stated: "The public character of this operation . . . dictate(s) that the utmost in quality and reliability be built into the control components and into their interconnecting structure."

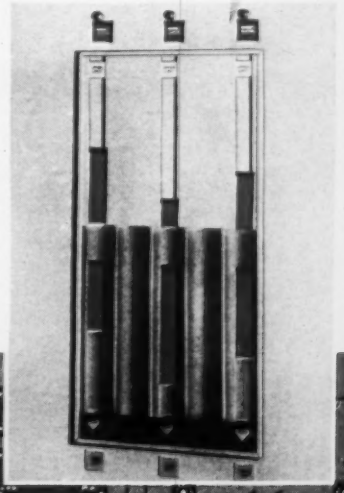
Panellit did the job!—engineered and built the system to exacting standards in 40 days and delivered it to Oak Ridge on time!

Project Aquarium is another example of the tough problems in control instrumentation solved successfully by Panellit.

Panellit designs, engineers and builds automatic control and information systems for atomic developments and the electric power and process industries.

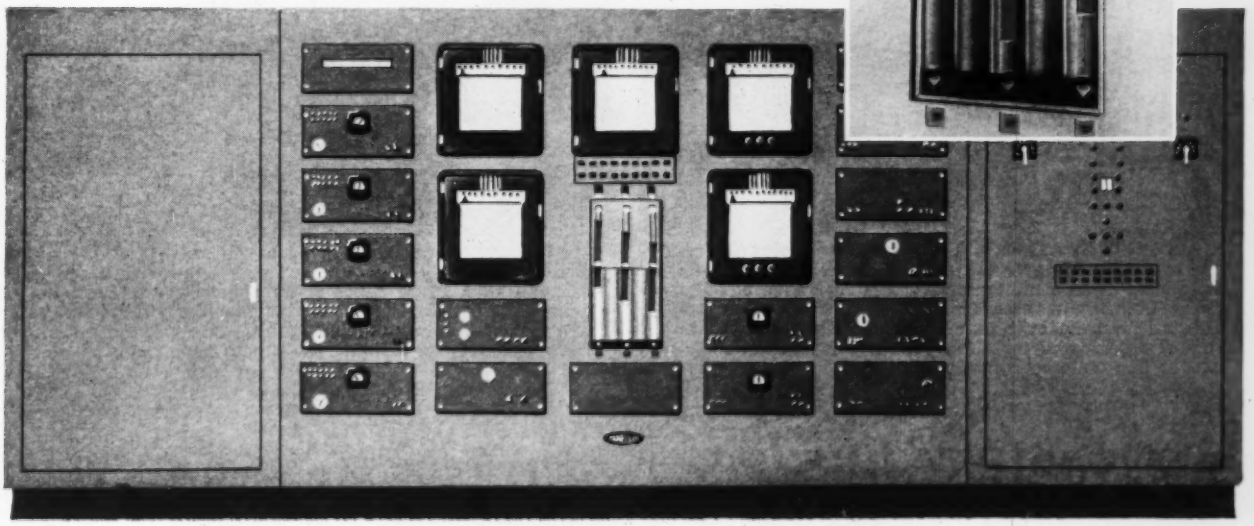
Write for literature on graphic control panels, central control rooms, alarm systems, and on scanning, monitoring and data reduction systems. **Panellit, Inc., 7405 N. Hamlin Avenue, Skokie, Illinois,** and in Canada, Panellit of Canada, Ltd., 60 Newcastle Street, Toronto 14.

PANELLIT



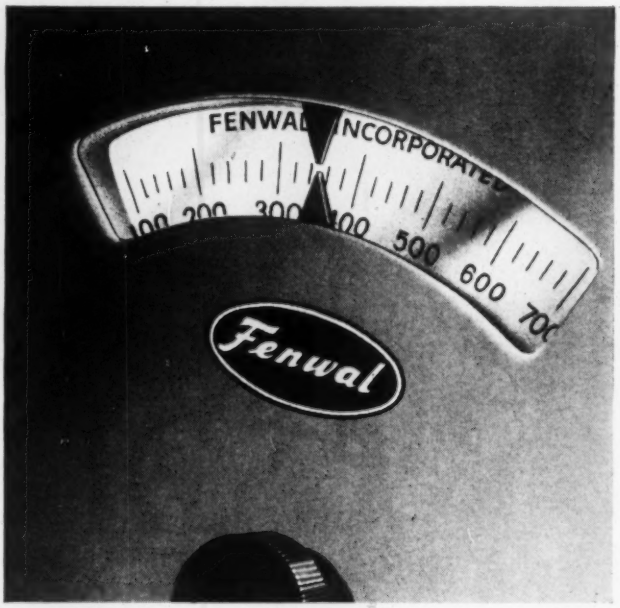
Reactivity is controlled by three movable rods inserted into the reactor core. Panellit designed this unique graphic indicator to depict the rod positions.

Control panel built by Panellit for Project Aquarium.



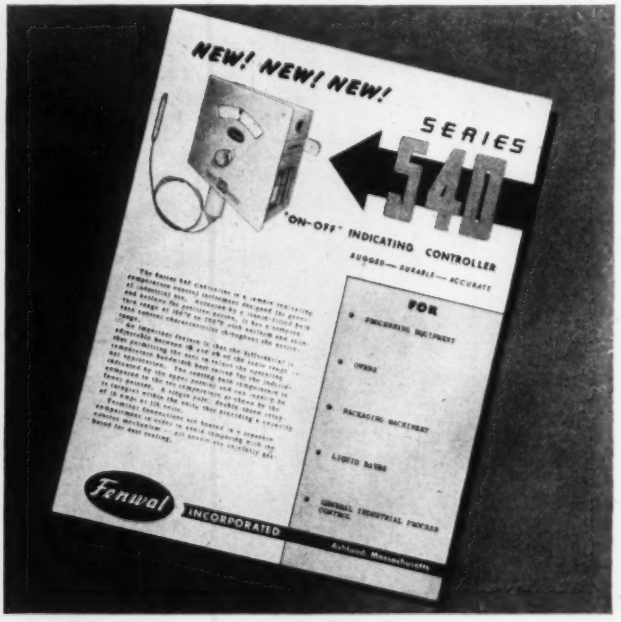
Now . . . a new Temperature Indicator-Controller by Fenwal

1. FENWAL'S NEW SERIES 540 is a remote Temperature Indicator-Controller that combines low cost with high accuracy over a temperature range of 100° to 700°F. Designed for ovens, packaging and processing equipment of all types, the new controller operates on a liquid-filled bulb and capillary system whose response to temperature changes is transmitted through a bellows to an indicating pointer. It may be flush-mounted or surface-mounted.



2. "SET" AND "CHECK" ARE EASY. Temperature setting pointer and bulb temperature pointer pivot on the same axis, indicating against the same scale face. This permits "glance" comparison of actual and set-point readings at considerable distance from the dial. An adjustable differential, variable between 0.8% and 4% of scale range, permits adjusting the operating bandwidth to balance closeness of control against slower cycling and longer equipment life.

3. ACCURACY IS ASSURED. Temperature indication is accurate to within 3% over the 100° to 700°F range, including the effects of ambient temperature in the range of 50° to 150°F. Accuracy increases for narrower ranges. Uniform control and accurate calibration are maintained with typical Fenwal precision in this new, popular-priced addition to a famous line of temperature control and detection devices.



4. SEND FOR NEW BULLETIN. Get all the facts on how closely the new Series 540 meets your requirements for an economical, accurate indicator-controller. Write for comprehensive bulletin MC122. And remember, we're always ready to help in any problems concerning temperature control and detection. **Fenwal Incorporated, 368 Pleasant Street, Ashland, Mass.**

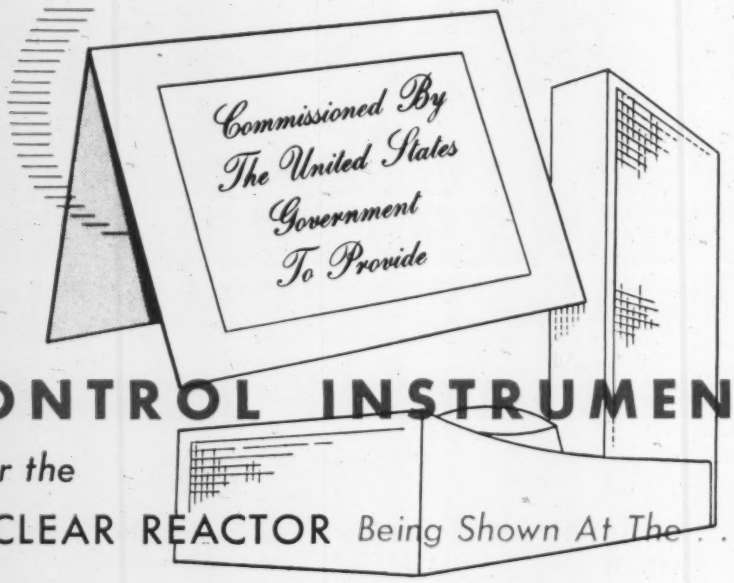
Fenwal Controls Temperatures . . . *Precisely*

For more information circle **47** on inquiry card.

wherever precise flow
measurement is critical . . .
Potter TURBINE TYPE FLOWMETER
ACCURATE, DEPENDABLE POTTER FLOWMETERS are being specified by more and more chemical processors each year for jobs that demand high reliability, high precision, low maintenance, extreme control precision. Available in sizes from 1/8" to 6" units, they measure caustics, acids, corrosives, unstable compounds, suspensions, super-refined liquids and other hard-to-handle liquids at temperatures up to 1200°F and at pressures to 35,000 psi. Easily incorporated into complex control systems because of their linear output, Potter sensing units produce a signal that can be telemetered, fed into digital information handling systems, or measured directly to indicate or control flow rate or total flow.
Find out how this unique approach to flow measurement can help solve your flow-control problems. Write for Bulletin S-1.
POTTER AERONAUTICAL COMPANY • Route 22 • Union, N. J. • Phone MUrdock 6-3010
Makers of "Potter Engineered" products

For more information circle **48** on inquiry card.

DAYSTROM INSTRUMENT

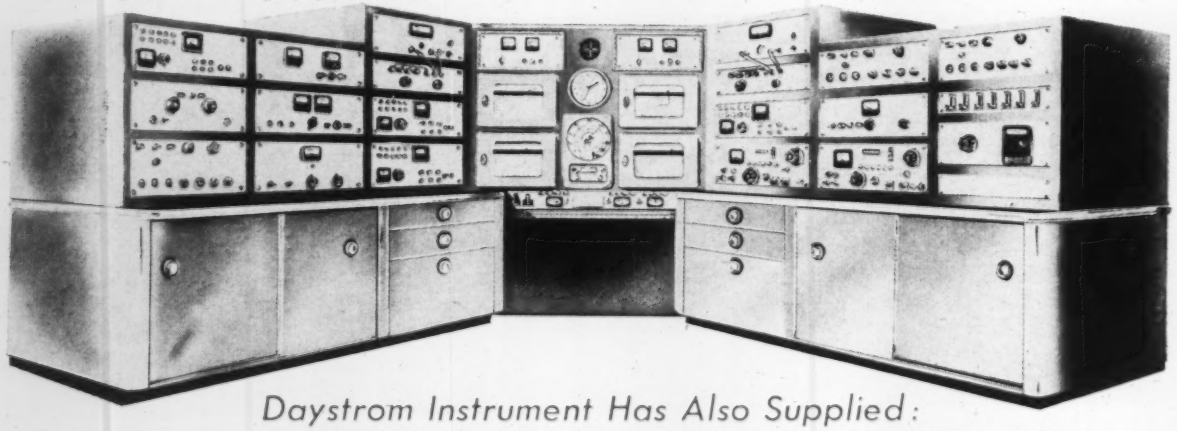


CONTROL INSTRUMENTATION

for the NUCLEAR REACTOR Being Shown At The . . . UNESCO CONFERENCE

Geneva, Switzerland

DAYSTROM INSTRUMENT is in full scale production of nuclear instruments for the Atomic Energy Commission and industry . . . and has the facilities, "know-how" and skilled manpower to supply control instruments tailored to your requirements. You can look to Daystrom for instruments of finest quality, utmost precision and top performance.



Daystrom Instrument Has Also Supplied:

Control instruments, computing mechanisms, test equipment for all branches of the Armed Services . . . and many of America's leading industrial concerns—as well as foreign companies.

For The AIR FORCE—

Capacitance Testers, All-Altitude Servo Indicators, Transistorized Receivers, R F Switches.

For The NAVY—

Radar Fire Control Systems, Mine Detecting Devices, Anti-Submarine Attack Directors, Catapult Speed Indicators, Servo Control Systems, Torpedo Assemblies.

For The ARMY—

Mechanical Fire Control Systems, Fuzes, Communication Systems and other instrumentation for all branches of the Army.

For INDUSTRY—

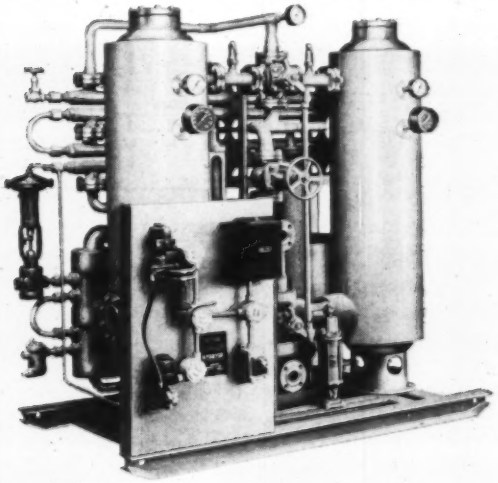
Test Equipment, Computing Devices, Radar Equipment, Nuclear Equipment. Gyros, Electronic and Electro-Mechanical Devices.

Write For Our Facilities Report

DAYSTROM *Archbald, Penna.* **INSTRUMENT** *Div. of Daystrom, Inc.*

For more information circle **49** on inquiry card.

AUTOMATION INSTRUMENTS MUST HAVE DRY AIR— THE PRITCHARD HYDRYER DELIVERS IT!



Precision instruments depend upon a constant source of exceptionally dry air to operate accurately. Instrument and plant shutdowns due to moisture, corrosion, icing are too expensive to be tolerated in the modern plant.

The Pritchard Hydryer®—a low-cost, packaged, dehydration unit—ends the possibility of moisture formation in instrument air.

The Hydryer removes moisture from air, carbon dioxide, synthesis gas and many other gases. It has been proved in use in the gas, chemical, petroleum, electric utility and general industries.

Exclusive design features make the Hydryer superior to any other such unit on the market today. Why don't you investigate these features?

WRITE TODAY for HYDRYER BULLETIN 16.0.081 on your company letterhead!

INDUSTRY'S PARTNER FOR PROGRESS

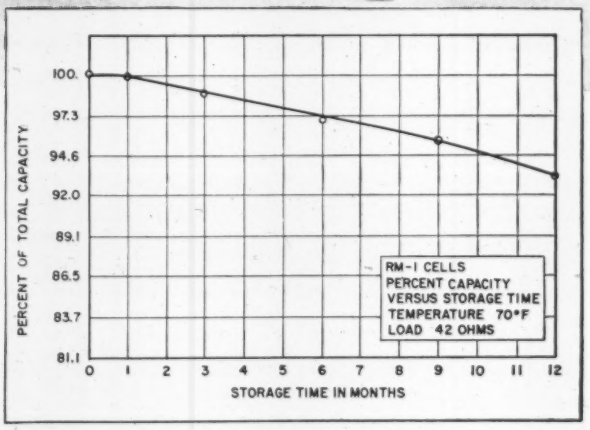
COOLING TOWERS
GAS & AIR TREATING EQUIPMENT

REPRESENTATIVES IN PRINCIPAL CITIES FROM COAST TO COAST

J.F. Pritchard & Co.
OF CALIFORNIA
A DIVISION OF J. F. PRITCHARD & CO.
Dept. 449 4625 Roanoke Parkway, Kansas City 12, Mo.

For more information circle **50** on inquiry card.

For Long Shelf Life... Use Mallory Mercury Batteries



For battery-powered instruments that operate intermittently . . . or for applications involving long periods of idleness, the long shelf life of Mallory Mercury Batteries is an important characteristic.

Mallory Batteries do not deteriorate or lose an appreciable amount of power during long storage periods, even under the most adverse conditions of humidity and temperature extremes. The curve shown is typical of the performance you can expect when Mercury Batteries are used for instrument power supply.

For continuous or intermittent operation at microampere drains or loads of 50 amperes, Mallory Mercury Batteries have many important advantages that will help you design lighter, more compact equipment . . . equipment that will give more hours of service life.

Let us send you a copy of our new Technical Bulletin 1-6. It contains complete information on single cells and multi-cell stacks and packs.

Here are other advantages that may suggest ways you can use Mallory Mercury Batteries to advantage

- High ratio of energy to volume and weight
- Leak-proof, dimensionally stable construction
- Uniform discharge characteristics
- No need for recuperation periods
- Operation over wide temperature and pressure ranges
- Resistance to humidity and corrosive conditions
- Highly resistant to impact and acceleration

For Transistor Applications

The constant voltage-constant current characteristics of Mallory Mercury Batteries make them exceptionally well suited to transistor applications.

P. R. MALLORY & CO. Inc.
MALLORY

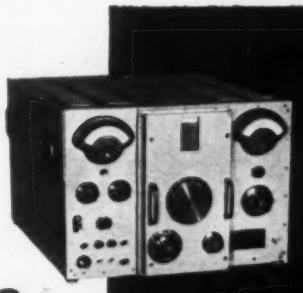
SERVING INDUSTRY WITH THESE PRODUCTS:
Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

P. R. MALLORY & CO. INC., INDIANAPOLIS 6, INDIANA

For more information circle 6 on inquiry card.

PACEMAKER IN

PRECISION ELECTRONICS...



BJ Hi-Power Standard Signal Generators

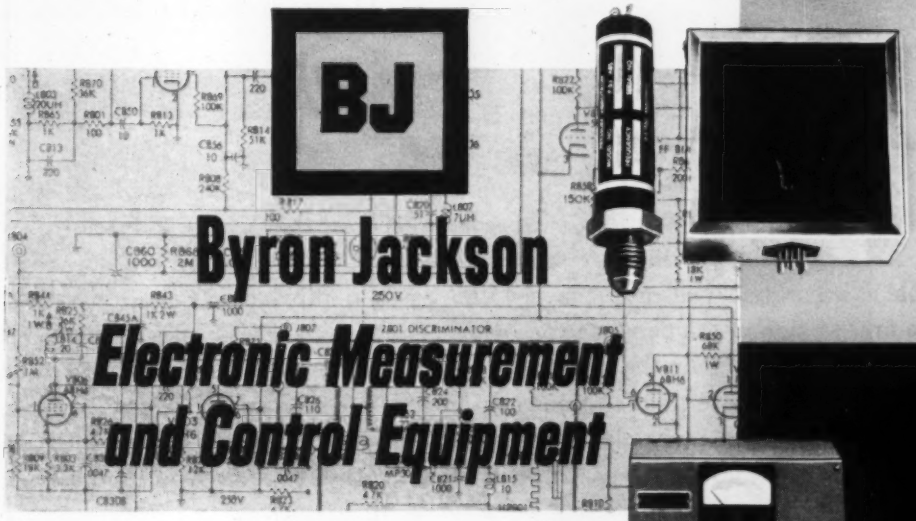
Model BJ-20A offers 10 watts output from 85 kc to 40 mc.

Model BJ-30A provides 5 watts output in the 40 mc to 400 mc range.

BJ

Byron Jackson

Electronic Measurement and Control Equipment



BJ Vibrotron Digital Pressure Gage

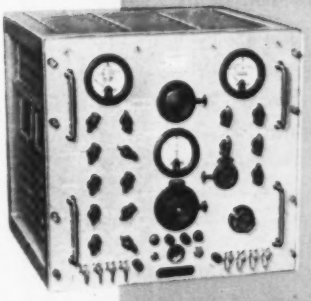
Offered in miniature and subminiature models for direct digital measurement and signaling of pressure, temperature or flow.

BJ Precision Slotted Lines

Laboratory standard precision slotted lines available in three models, with indicator or RF Wattmeter.

More than ten years of leadership in the development and manufacture of precision electronic instruments and gages is demonstrated in this BJ-Rollin line of equipment. Complete technical bulletins are available on these products as well as BJ equipment in the microwave field.

SPECIAL MEASUREMENT PROBLEMS? Our engineers and scientists are ready to work with you in the development of special measuring and testing equipment as well as complete systems.



Multipurpose Signal Generator

A standard signal generator which combines the functions of CW, AM, FM, PM, and sweep.

BJ

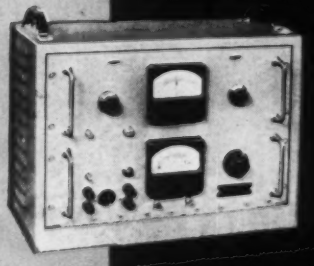
SINCE 1872

Write or telephone for details:

Byron Jackson Co.

ELECTRONIC DIVISION

Mailing Address: P.O. Box 2017, Terminal Annex
Los Angeles 54, California • Telephone: RYan 1-5166



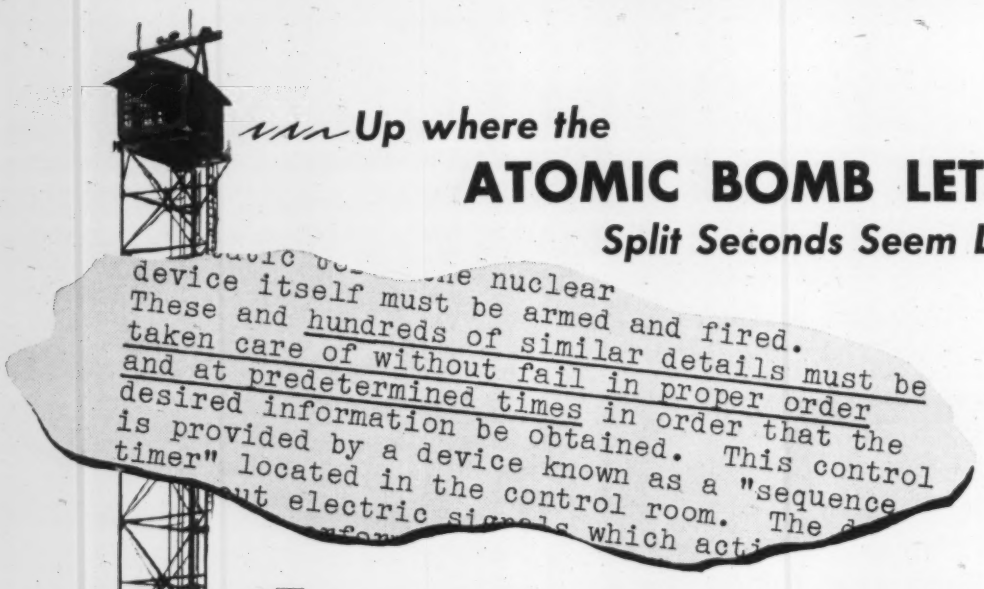
BJ Incidental FM Meter

Measures incidental deviation of a carrier in the presence of AM.

Visit Byron Jackson Booth No. 1802, Wescon Show—August 24, 25, 26

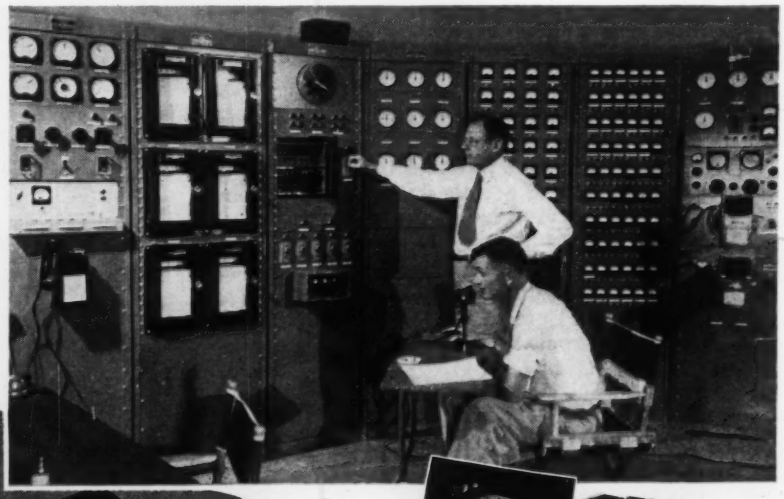
For more information circle **52** on inquiry card.

Up where the
ATOMIC BOMB LETS GO
Split Seconds Seem Like Eternity


nuclear
device itself must be armed and fired.
These and hundreds of similar details must be
taken care of without fail in proper order
and at predetermined times in order that the
desired information be obtained. This control
is provided by a device known as a "sequence
timer" located in the control room. The
which

THIS EXCERPT from the "Guide for Observers' Tour of the Control Point and Forward Area, Nevada Proving Grounds" highlights the importance of equipment capable of accurately measuring elapsed time down to unbelievably short intervals.

The first section of the panel shown below is used only for air bursts. The second and third sections contain the frequency control equipment for the motor-generator set which supplies power to the timing equipment, with voltage recorders connected to various points in the target area – thus assuring accurate timing – and recorders for wind velocity and direction. In order to activate test equipment at the exact time, very precise control of the frequency for the timer is required ... The precision timers on the fourth and seventh sections are by STANDARD.



Complex instrument panel in Control room of Control Point, Yucca Pass, Nevada Proving Grounds

The STANDARD ELECTRIC TIME COMPANY

STANDARD
Since 1884

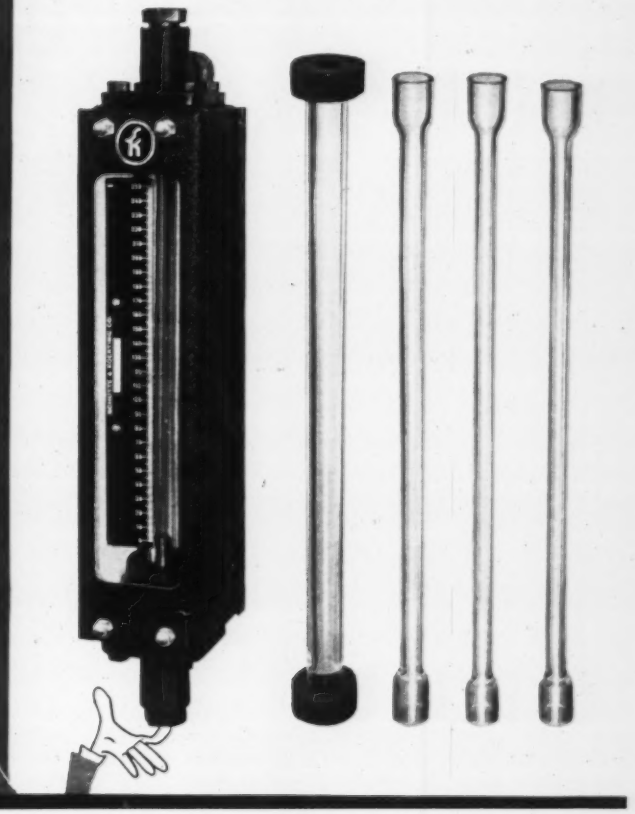
93 LOGAN STREET • SPRINGFIELD 2, MASSACHUSETTS

PRECISION TIMERS • CHRONO-TACHOMETERS • LABORATORY PANELS • PIPELINE NETWORK ANALYZERS

For more information circle **53** on inquiry card.

The versatile ROTAMETER for continuous or batch processing

wide range of capacities within one meter size lets you measure flow under changing conditions



Ever wish for a *versatile* meter? One that adapts *in minutes* to changing rates of flow? You get your wish *with the SK Safeguard Rotameter because* . . .

. . . *Four Sizes of Tubes*, each offering a different capacity, can be used in a single Rotameter.

. . . *Tubes Interchange Quickly*—can be removed and replaced to meet changing conditions.

. . . *Exclusive Belled Ends* of tubes, all having same inlet and outlet OD, permit standardization of end fittings and packings. No special tools or fittings needed.

. . . *Numerous Rotor Designs* can be used within one meter tube to provide wide range of capacities.

Where flow rates change frequently, as in proportioning dissimilar fluids, you'll find the *SK Safeguard Rotameter* outstandingly convenient and economical. Accurate, durable and safe, too, because . . .

. . . Meter Case of Strong, Rigid Steel completely encloses tube—protecting against external shock, acting as a safeguard should tube break accidentally.

. . . Heavy Gauge, Safety Glass Windows provide excellent view of tube, rotor and scale.

. . . Detachable Metal Reference Scale is clearly marked for easy reading—can be supplied in units of flow, or in millimeters for use with calibration charts.

. . . Bronze, Cast Iron or Stainless End Fittings are designed to permit connection to piping in any of four horizontal positions.

. . . Non-leaking, Seated, Clean Out Plugs at top and bottom of end fitting permit rotor removal and tube cleaning without disassembly.

. . . Packing Glands are adjustable from outside of case by means of stainless steel capscrews.

Get Your Free Copy of Bulletin 18-RG. It details operating principles, sizes and dimensions, construction features of SK's Safeguard Rotameter. Yours without obligation.

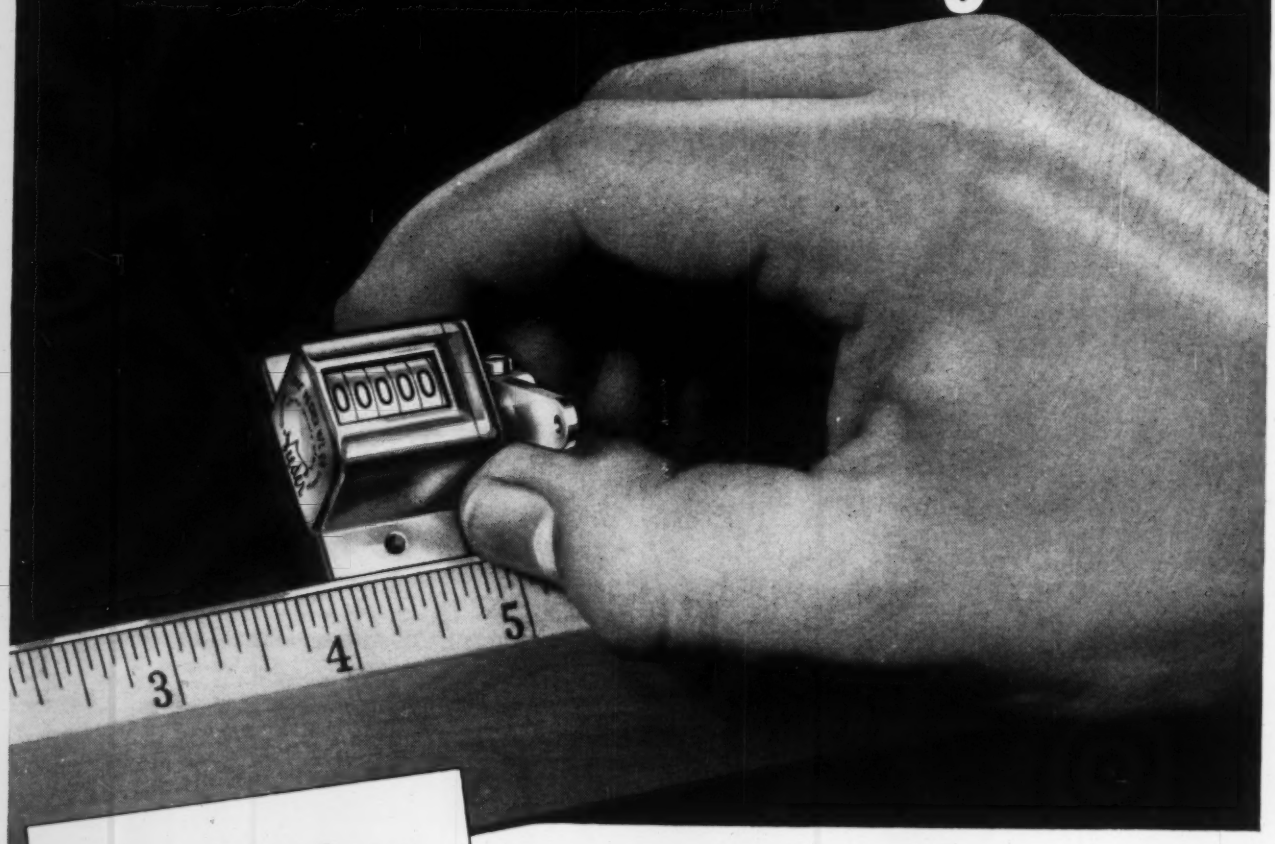
Schutte and Koerting
COMPANY
MANUFACTURING ENGINEERS

2225 STATE ROAD, CORNWELLS HEIGHTS, BUCKS COUNTY, PA.

Jet Apparatus • Heat Transfer Equipment
Strainers • Condensers and Vacuum Pumps
Oil Burning Equipment • Rotameters
Flow Indicators • Radiafin Tubes • Valves
Spray Nozzles and Atomizers • Gear Pumps
Desuperheaters

For more information circle **54** on inquiry card.

This Small Counter
Does a Whale of a Big Job!...



Added Evidence that —

Everyone Can Count on VEEDER-ROOT

For its size . . . *less than one inch square* . . . this Veeder-Root Small Square-Case Counter is the most rugged instrument of its type, with the longest accurate life. And only Veeder-Root makes it this way . . . square all the way through . . . extra strength built-in, with bearing surfaces on *both* ends of the drive shaft.

What's more, this counter is 100% American . . . made by Connecticut craftsmen to unmatched standards of quality and precision. And it's the "counter of countless uses" . . . built into everything from office machines and cameras to taxi meters and voting machines. Now what do *you* make that could count its way to bigger sales and profits with a Small Square-Case Counter built-in as a standard part? Write:

VEEDER-ROOT INCORPORATED
HARTFORD 2, CONNECTICUT
Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

'The Name that Counts'

For more information circle **55** on inquiry card.

BOWSER

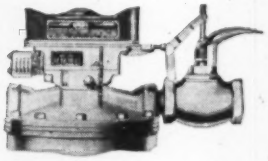
ESTABLISHED 1885

Automated

liquid handling is not new

FLOW INDICATORS AND CONTROLS

Bowser's many years of experience are yours when you consider improved liquid-handling facilities for your operation. Here are examples of equipment applicable for automatic processing or production of industrial liquids . . . perhaps your product . . .



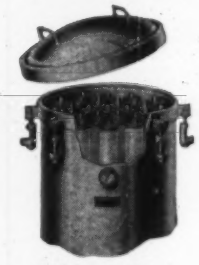
Optional repeating meter dial delivers predetermined quantities automatically.

Optional recording printer mounts on meter. Prints quantity of liquid metered.

XACTO METERS

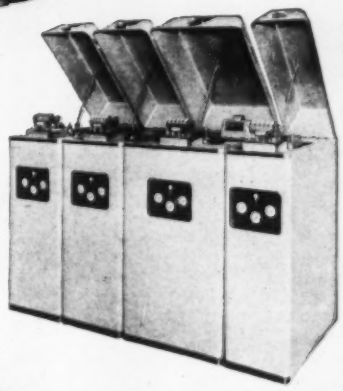
There is a Bowser Meter for nearly every product and application. Xacto Meters are standard in most industries. Broad capacity range. Choice of many dials and metal construction. Only a few are shown at left.

FILTERS



EXPENDABLE CARTRIDGE TYPE

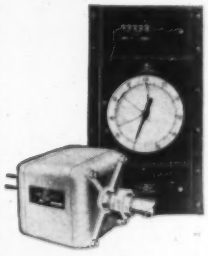
A wide range of Bowser filters and dehydrators is available for both oil and aqueous liquids in batch and continuous operations. Cartridge-type for oils is shown at left.



BLENDING SYSTEM

Accurately blends two or more liquids in desired proportions for continuous or intermittent line production. Each ingredient is metered and recorded for uniformity in closed, piped system. Blends oils, beverages, chemicals, liquid foods, etc.

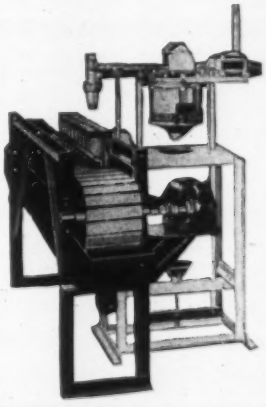
ELECTROMAGNETIC METERS



HANDLES CONDUCTIVE LIQUIDS WITH SOLIDS ENTRAINED

The Bowser "Xactronic" provides straight-line metering for conductive liquids, slurries, acids, etc., except oils. High-pressure or suspended solids are no obstacle. Exposed parts are Teflon and stainless steel.

PACKAGING UNITS



Available in many capacities. Electric or manual control. May be set for any quantity. Temperature and specific gravity adjustment dials provide greatest possible accuracy. Widely used for can and barrel filling. With or less conveyor.

CHECK ITEMS OF INTEREST BELOW AND MAIL COUPON FOR LITERATURE

XACTO METERS FOR INDUSTRIAL LIQUIDS ☐

BLENDING SYSTEMS FOR PRODUCTION ☐

PACKAGING UNITS FOR LIQUID PRODUCT ☐

INDUSTRIAL LIQUID FILTERS ☐

ELECTROMAGNETIC METERS ☐

DATE_____

NAME_____ TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ STATE_____

PRINCIPAL LIQUIDS_____

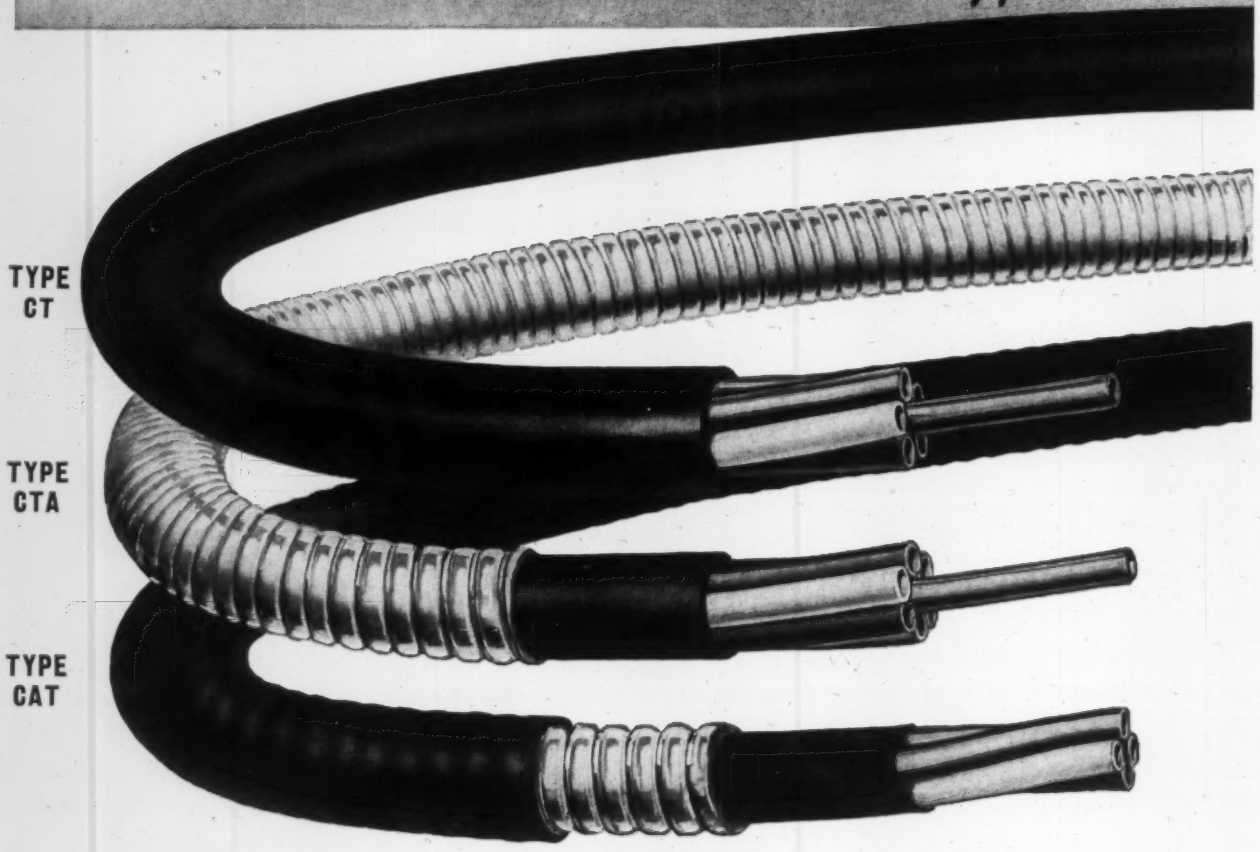
BOWSER, INC., FORT WAYNE, IND.

1367 E. CREIGHTON AVE.

For more information circle **56** on inquiry card.

CRESCENT ARMORED MULTITUBE

In 3 Corrosion Resistant Types



For Pneumatic and Hydraulic Instrument Controls

TYPE CT—In damp or corrosive locations where a moderate degree of mechanical protection to the tube is required, as in troughs or attached to building surfaces or supporting means, the construction shown in top view is recommended. It employs a tough corrosion-resistant thermoplastic sheath, resistant to water, acids, alkalies, oils, most chemicals, and is flame-retardant.

TYPE CTA—Where maximum mechanical protection is desired during or after installation, such as direct burial in concrete and pulling into conduit, an interlocked galvanized steel armor over the thermoplastic sheath, as shown in middle construction above, is recommended.

TYPE CAT—For maximum protection against corrosion and mechanical injury to the tubing, the thermoplastic sheath is applied over the flexible steel armor as shown in the bottom construction illustrated above.

These forms also provide the other advantages possessed by CRESCENT ARMORED MULTITUBE which include permanence, lower over-all cost and ease of installation.

CRESCENT ARMORED MULTITUBE consists of long length tubes **TWISTED TOGETHER** to permit bending without distortion. In each layer one tube is a bright blue color, affording a fast means of identification from both ends.

Available in long runs up to 1000 feet and up to 19 tubes of copper, aluminum or polyethylene tubing in size ¼" O.D. This product is licensed under U.S. Patent 2,578,280.

Send for bulletin giving complete information and engineering data.

CRESCENT INSULATED WIRE & CABLE CO.

OLDEN & TAYLOR AVES., TRENTON, N. J.

For more information circle **57** on inquiry card.

ENGINEERING

RESEARCH & DEVELOPMENT

There are Qualities *Behind* ANNIN VALVES you'll never find in imitations

QUALITY CONTROL

EXPERIENCE

ANNIN DEVELOPED AND INTRODUCED:

SPLIT BODY

The Annin split-body design has given Industry new standards in control valve construction: lower body pressure loss, greatly reduced erosion, greater rangeability, longer life and reduced maintenance.

DOMOTOR OPERATOR

Out-performs all other pneumatic valve actuators. They are the highest speed, most powerful, and provide the best response characteristics. Long strokes assure that all size valves are truly hi-lift control valves.

TEFLON SEAT SEAL

The teflon seat seal for absolute tight closure, teflon guide bushing to eliminate guide clearance, and teflon V-ring packing for reliable stuffing-box performance were developed and introduced by Annin.

DOOLSEAL

Providing a new high in stuffing-box practice, the Doolseal, originally developed and introduced by Annin, assures reliable seal for hard-to-handle or toxic chemicals without resorting to mechanical seals.

...and many others!

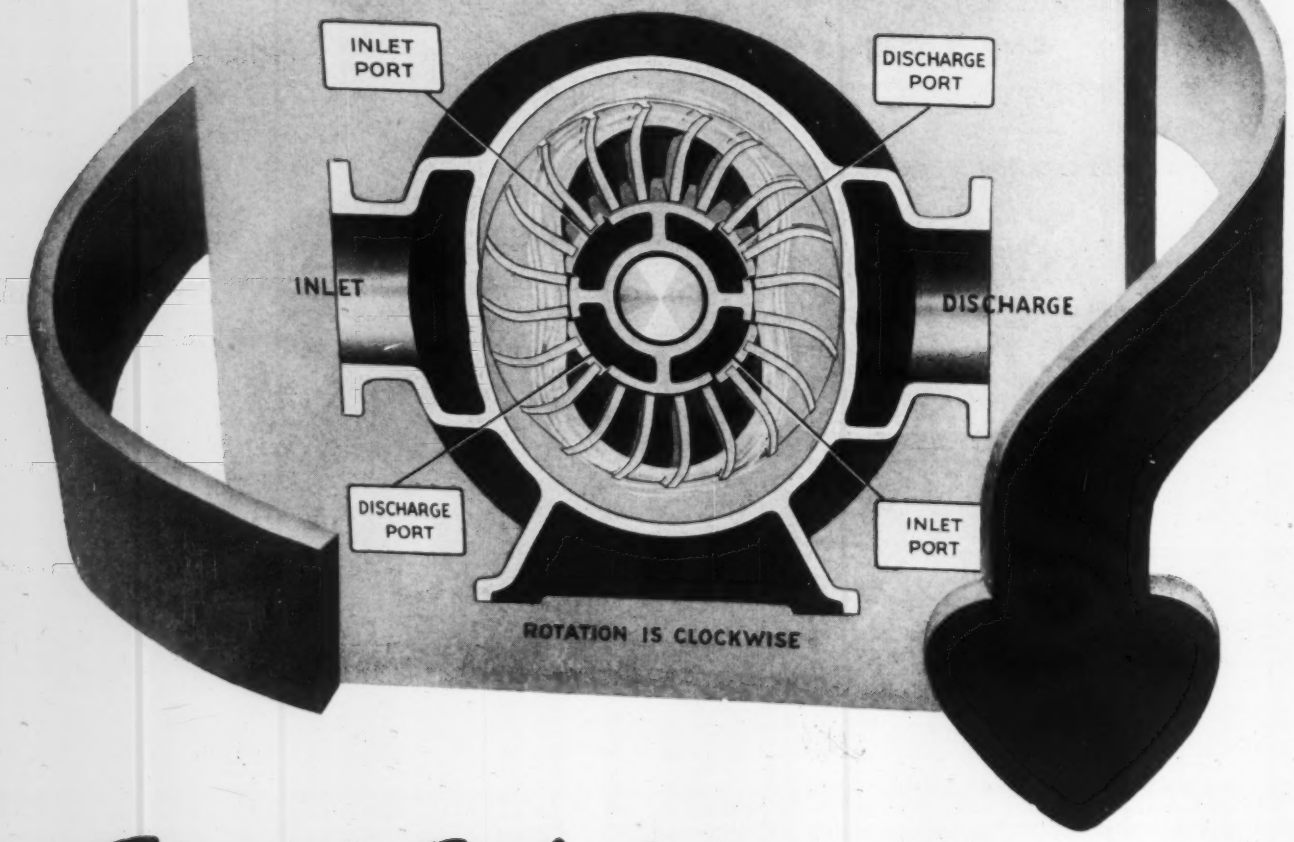
CUT INVENTORY 50% WITH

ANNIN *Control* VALVES

THE ANNIN COMPANY
6570 East Telegraph Road
Los Angeles 22, California

For more information circle **58** on inquiry card.

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters



Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.
No dust filters.
No internal lubrication to contaminate air handled.
No internal wearing parts.
No valves, pistons, or vanes.
Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

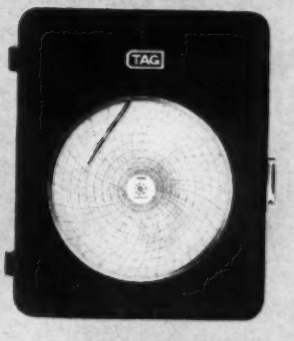
NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.

to regulate and record—

TEMPERATURE.. PRESSURE.. VACUUM..TIME

mechanical instruments by

WESTON



RECORDING INSTRUMENTS . . . in 9", 10" and 12" chart sizes — single and multipen — for all requirements.

RECORDING CONTROLLERS . . . handle temperatures from —325°F to 1000°F—vacuum to 30" mercury — pressures to 7500 psi or higher.

TIME CONTROLLERS . . . make any semiautomatic retort control system fully automatic. Available in both standard and special forms.

INDICATING CONTROLLERS . . . accurately regulate temperature, vacuum, pressure and indicate on direct-reading scale.

DIAL THERMOMETERS (remote reading) . . . furnished with mercury, gas, or vapor pressure actuations. Flush or wall mounting. Indicate low as —325°F., high as 1000°F.

Just Published!

Just published . . . the new catalog M2A which fully illustrates and describes the comprehensive line of WESTON mechanical instruments, noted for their long-time accuracy and dependability. Send for your copy today; or ask your local Weston representative for help on any measurement or control problem involving temperature, vacuum, pressure. Weston Electrical Instrument Corporation, 614 Frelinghuysen Ave., Newark 5, N. J., *a subsidiary of Daystrom Inc., 200 Elmora Ave., Elizabeth, N. J.*

WESTON *Instruments*

For more information circle **59** on inquiry card.

A new concept in . . .

instrument adaptability

WITH SPEEDOMAX® H

Whether you melt metal, refine chemicals or bake bread, there's a Speedomax H available for the job.

For this complete line of electronic temperature instruments is being quantity-produced from a series of standard, integrated components.

Null-balance potentiometer indicators or indicating recorders . . . with either round or strip charts . . . can be combined with the type of control action best suited to your process needs. Whether you need simple or multiple action control . . . instrument and control components come to you as one integral unit.

And all proportioning control chassis are interchangeable. You can select the instrument to fit your process now, and at any time modify it to meet new conditions . . . quickly and economically.

To see the features of this unique instrument, get our pictorial fold-out which takes you inside Speedomax H. Just phone your nearest L&N office or write us at 4955 Stenton Ave., Phila. 44, Pa. Ask for Die-Out ND46(1).

LEEDS *instruments* **NORTHRUP** *automatic controls • furnaces*

For more information circle **60** on inquiry card.

Editorial...

INSTRUMENTS and AUTOMATION

Automation and Culture

CULTURE, according to an accepted definition is "the refinement of mind, morals, and tastes; enlightenment or civilization." The culture we shall discuss is that pertaining specifically to morals, inasmuch as the refinements of the modern technical mind are used today as much to brutalize as to ennoble civilization; as much for destruction as for creation. Further, the moral implications of culture will determine, in the long run, what happens to our minds and tastes. Thus the moral implications are the most important aspect of any cultural problems that may be raised by automation.

It is often stated by many who have recently discovered the field of automatic control that the automated society of the future will have more leisure time and hence (Q.E.D) more culture. Unfortunately, there is little factual proof with which to equate leisure time and culture. Leisure time can erode the soul as well as enlighten thought and purpose. Are the cultural implications of a 30- or 20- or 10-hour workweek any different from that of the 40-hour workweek? And is the leisure time available to the many millions of citizens now working a mere 40 hours per week (and this only nominally) making for an increase in the cultural level of our society? Merely to state the question is to answer it.

Teachers and educators in general, the core of a cultured society, are being ground to pieces between the triple millstones of inflation, public apathy and political demagogy. Billions for armaments—or roads; but only conferences for educators who keep referring plaintively to the problems of their low wages and crowded classrooms.

Artists, philosophers, poets and musicians have the alternatives of commercializing their talents to make a living, abandoning their profession, or starving. Even those minor sources of meager remuneration for these groups—the private foundations—are under attack by rampant political demagogs.

BUT the cultural level of a society is not established by the treatment given educators and philosophers. In the final analysis the degree of cultural attainment of a society depends on the morals of the individual citizen, which factor is both and at once the heritage of the past and the guide into the future.

One characteristic of the cultured individual is understanding of the past, and the identification of his existence with the struggles of those who fought for the good things he now enjoys. Most of mankind now accepts to some degree the concepts of love, charity, and freeedom —but how many of us know how these concepts came about, who fought for them, and what forces opposed them? This type of knowledge is not gained from newspaper stories or magazine articles, whose glamorized versions of history are doubly diabolical—they subvert the heritage and destroy it while paying lip service to it. Perhaps nowhere is the evil of superficiality more apparent than in the modern treatment of our priceless heritage of political freedom. True scholars have spent lifetimes illuming the real history of civilization; their books lie in nearly empty libraries while many leisure-ridden 40-hour-workweek citizens read the syndicated political newspapers and watch television. Will more leisure make for more culture? Where is the evidence of the past?

But it is not enough to condemn or decry. Culture is as near as the library, theater, and local auditorium and meeting hall. The books that those of us who want more culture should read are books that analyze our past; that discuss the history and concepts of society, happiness, religion, democracy, etc. The plays we should see are those that treat the problems of this or any age with understanding; each has a powerful, important, and timeless moral. (It is a sign of our time that sexually-slanted musicals attract crowds for years while powerful works play to small audiences for only short runs.)

Even the movies can be made a positive force for culture—let us ignore the trash, the inconsequential, the superficial—and support the profound, delicate, and human works. Indeed, as the first order of business, let us all learn to distinguish the profound from the superficial in all fields. Our public auditoriums and meeting halls are something we all should know intimately—here is where we can hear symphonies, folk dances, debates or talks. All of this is culture, positive culture, for which every modern citizen already has ample time.

ARTISAN skills, which are not unrelated to culture, may be affected by the growth of automation. A common complaint of the past has been that the soulless first Industrial Revolution destroyed the artisan skills of yesteryear. One does not need to be a professional artisan to find self-expression in terms of painting, writing, poetry, woodworking, music, weaving or any of a host of pastimes often referred to as hobbies. As the greater leisure of the automated society becomes available, there should be increased interest in, and practice of, all artisan skills. The modern productive society makes it possible for each person to develop artisan skill for the sheer joy of creating, for expression of the inner self. This is true art—more so than the forced labor of the artisan who had to produce the chair in order to earn a living. Automation could make possible a true rebirth of the arts—in terms of the individual. But this will happen only if we

wish to be artistic or cultured or refined—not because the leisure time is available; it already is available.

First, and most important, let us recognize that culture depends in the final analysis on our morals, our enlightenment, our civilization. Every individual must inquire more deeply about his place in society, the effect of his daily work on society, the meaning of society. Only in this way can we say, and mean, that we are living the good, cultured life. There are no other cultural implications associated particularly with automation; the problem of culture is a problem for today—not for the automated tomorrow.

Automation has led to much use of the term "robot," which is defined as "an automaton who performs all hard work, one who works mechanically and heartlessly." How many of us are robots already?

MHA

References on "Ice Point"

To the Editor:

I noticed your editorial on the freezing point of water in *Instruments and Automation*, May, 1955.

May I quote from Arnold Weissberger (ed.), *Physical Methods of Organic Chemistry*, Vol. I, Part I, Interscience Publishers, Inc., New York, 1949, pp. 2-3:

> "The basic fixed points of the International Temperature Scale are the Temperatures of the following equilibria at a pressure of one standard atmosphere: —(b) ice and air-saturated water, 0.000°;"

Mr. Coleman is correct, provided the condition of one standard atmosphere is also specified.

The use of secondary sources, such as the *Handbook of Chemistry and Physics* in matters like these is much to be deplored.

I have asked the Chief of the Thermometry Section of the National Bureau of Standards to write you.

Dr. J. Kenneth O'Loane
Eastman Kodak Company
Kodak Park Works
Industrial Laboratory
Rochester 4, New York

To the Editor:

It has been brought to our attention by Dr. J. K. O'Loane of the Eastman Kodak Company that differences of opinion as to the definition of the "Ice Point" have recently been expressed in your journal, *Instruments and Automation*. In view of this, some comments and authoritative references may help to clarify the situation.

The International Temperature Scale was adopted at the 7th General Conference of Weights and Measures in 1927 and was revised at the 9th General Conference in 1948. The official text of the scale and its revision are to be found in the Comptes Rendus des Seances of the conferences. The "Ice Point" is one of the six fixed points of the scale. In 1927 it was defined as "Temperature d'equilibre entre la glace et l'eau saturee d'air a la pression d'une atmosphere normale (point de fusion de la glace)—0.000°. In 1948 it was defined as "Temperature d'equilibre entre la glace et l'eau saturee d'air (point de fusion de la glace) (Point fixe fondamental)—0°; the pressure having been defined at the head of the table.

In 1928 the definition was translated (Bureau of Standards Journal of Research 1, 625 (1928) as "Temperature of equilibrium between ice and air-saturated water at normal atmospheric pressure (ice point)—0.000°. In 1949 (Journal of Research of the National Bureau of Standards 42, 209, (1949) the translation corresponded to the first. The French assure us that the expression "point de fusion de la glace" is an idiom which is equivalent to our idiom "Ice Point". The "melting point of ice," according to our ideas, is a temperature different from the "ice point," but that doesn't seem to bother the French.

According to Beattie et al (Proc. Am. Acad. of Arts and Sci. 72, 137, 1938) the temperature of equilibrium between ice and water is lowered 0.00244 deg. when the water becomes saturated with air at one atmosphere. According to our computations a pressure increase from the triple-point pressure to atmospheric pressure lowers the equilibrium temperature by 0.00749 deg. The sum of these two is so near 0.01 deg. that a resolution was adopted at the 9th General Conference as follows: "With the present-day technique, the triple point of water is susceptible of being a more precise thermometric reference point that the 'melting point of ice.' The Advisory Committee considers, therefore, that the zero of the thermodynamic centigrade scale should be defined as being the temperature 0.0100 degree below that of the triple point of pure water."

In the part of the text of the International Temperature Scale giving "Recommendations" for the realization of the scale there is a section describing the realization of 0°C with ice and water. This is followed by the statement: "It is recommended, however, that for work of the highest precision the zero point be realized by means of the triple point of water, a point to which the temperature —0.0100°C has been assigned."

J. F. Swindells, *Chief*
Temperature Measurements Section
National Bureau of Standards
Washington 25, D. C.

Erratum

To the Editor:

I have received a number of inquiries from your readers concerning a news release describing our "Pressure-Controlled Hydraulic Balance," (*Instruments and Automation*, 28:338, March 1955) drawing my attention to a probable error in the reported accuracy of the temperature control. On checking the article I discovered that the accuracy was stated as being within 0.0001°C. instead of 0.001°C. This was a typographical error on the part of the News Agency issuing the material. As the degree of accuracy is important, we would appreciate a correction note.

Wolfgang Haller
Research Associate
University of Toledo
Toledo 6, Ohio

ISA Conference and Exposition

On the following pages (1243-1255) we bring you a list of exhibitors and exhibited products at the ISA National Convention and Exposition, September 12-16, Shrine Exposition Hall and Auditorium, Los Angeles. Those of you who can't join the Westward movement this year can keep in touch with the exhibits by letting us know the exhibited products about which you want more information. We will see that you get it.

EXHIBITORS and their PRODUCTS

Booth No.

Abrams Instrument Corp., Lansing 1, Mich. C-510-2
Intervalometers; camera controls; magnetic counters; recording cameras; photogrammetric instruments; fire controls; programming devices.

Acro-Mu Switch Div., Acro Mfg. Co., Columbus 16, Ohio C-523-1
Precision snap-action switches; machine-tool and sub-miniature switches.

Allegany Instrument Company, Inc., Cumberland, Md. A-186
"Dynamation" instruments; d-c amplifier; high-gain amplifier for penmotors; miniaturized potentiometer; strain-gage calibrator.
See ad on page **1244** Circle **61, 63** on inquiry card.

D.C. AMPLIFIER, Model 307

Gain: 1 millivolt input for ± .030 amp into 5-60 ohms.
Output (maximum): ± 60 mils
Input Impedance: 20,000 ohms
Frequency Response: d.c.—5000 cycles
Use: galvanometer recorders

Allegany Instrument Company, Inc.

For more information circle **61** on inquiry card.

American Cystoscope Makers, Inc., New York 59, N. Y. B-321
Borescopes.

American Helicopter Div. of Fairchild Engine and Airplane Corp., Manhattan Beach, Calif. C-500-1
Bridge-balance equipment; resistance-bridge indicators.

American Instrument Company, Inc., Silver Spring, Maryland ..... A-183 & 184
Humidity measuring and controlling equipment; chemical proportioning pump; Kjeldahl digestion apparatus; "Magne-Gage"; "Magne-Probe"; sub-zero cabinet; forced-convection oven.

American Phenolic Corp., Chicago 50, Ill. A-166
AN and microphone connectors; tube sockets; RF cable; antennas; cable assemblies; components; molded and fabricated plastics.
See ad on pages **1272, 1273** Circle **112, 113** on inquiry card.

American Recording Chart Co., Los Angeles 23, Calif. C-506
Recording charts; gravitometers.

Ampex Corp., Redwood City, Calif. B-451
Magnetic tape recorders.

Analytical Measurements, Inc., Chatham, N. J. A-167
Pocket and industrial ph meters.
See ad on **Inside Back Cover** Circle **218** on inquiry card.

H. Reeve Angel & Co., Inc., New York 7, N. Y. A-264
Filter papers for chromatography, electrophoresis and routine filtrations; non-cellulose specialty papers.

Angus-Campbell, Inc., Los Angeles 58, Calif. C-522
Nylon; electrical alloys; polyethylene; polystyrene; resin coated wires & cables; Saran; Teflon; Vinylite.

The Annin Co., Los Angeles 22, Calif. ..... A-237 & 238
Positioning value operators; pneumatic-lock continuous handwheel operator; "Domotor" and other control valves.
See ad on page **1237** Circle **58** on inquiry card.

VISIT OUR BOOTH A131-132

Optical Emission Quantometer and X-Ray Spectrometer in operating demonstration.

Applied Research Laboratories,
Glendale, California

For more information circle **62** on inquiry card.

Booth No.

Applied Research Labs., Glendale 8, Calif. ..... A-131 & 132
Analytical Quantograph; X-ray scanning spectrometer.
Circle **62** on inquiry card.

Askania Regulator Co., Chicago 11, Ill. ..... 396, 397 & 398
Electric valve-positioner; pilot valve (electro-hydraulic converter), valves and operators; edge-position and register controls.
See ad on page **1253** Circle **92** on inquiry card.

Assembly Products, Inc., Chesterland, Ohio A-150
Meter-relays; VHS relays; API panel meters and pyrometers; "Simplytrol" and "Versatrol" controls.
See ad on page **1246** Circle **72** on inquiry card.

Associated Research Inc., Chicago 18, Ill. A-188
Hayward dual-sensitivity voltmeter; "Hypots"; "Vibra-grounds"; "Vibrotests."

Automatic Electric Sales Corp., Chicago 7, Ill. ..... A-161 & 162
Relays and switches (telephone types).
See ad on page **1216** Circle **37** on inquiry card.

Automatic Switch Co., Orange, N. J. ..... A-103 & 104
2-way, 3-way, 4-way solenoid valves; electromagnetic controls; standard and special relays and contactors; automatic transfer switch.
See ad on page **1172** Circle **51** on inquiry card.

ATC Co. (Auto. Temp. Control Co., Inc.), Phila. 44, Pa. B-334, 335, 336
Electronic switches; transducers, timers; transducers servo kit; electronic edge detector; thickness caliper.
See ad on page **1244** Circle **64** on inquiry card.

Automation Instruments, Inc., Pasadena, Calif. A-287
Pressure indicators; accelerometers; displacement gages; engine load indicators; microscopes.

A-V Manufacturing Corp., New York 19, N. Y. C-511
Magnetic tape recording equipment.

Bailey Meter Co., Cleveland 18, Ohio C-527
D-c receiver recorder; plug-in electronic receivers; plug-in pneumatic receivers, integrators and controllers; time-cycle controllers; control station, vertical gages; electric and pneumatic transmitters; combustibles analyzer-recorder; smoke density recorder; "Armortube" multitube cable.
See ad on page **1200-1201** Circle **24** on inquiry card.

The Baker Company, Inc., Maplewood, Maine A-123
Torque testers; "Sterilshield" dust free cabinets; ultrasonic bearing washer; instrument bearing tools.

Barksdale-Meletron, Los Angeles 58, Calif. ..... B-368, 369, & 370
"Meletron" pressure switches for vacuum to 12,000 psi.

Barton Instrument Corp., Los Angeles 22, Calif. ..... A-133 & 134
Meter body; differential pressure indicator, recorder, switch, and transmitter.
See ad on page **1271** Circle **110** on inquiry card.

Arnold O. Beckman, Inc., S. Pasadena, Calif. ..... B-419 & 420
Oxygen and dissolved-oxygen analyzer; pocket dosimeters and chargers; gas analyzer; density balance; titration chemometer.
See ad on page **1289** Circle **133** on inquiry card.

Beckman Instruments, Inc., Fullerton, Calif. ..... B-377 thru 384
pH meters and systems; data-handling systems; infrared and ratio-recording spectrophotometers; "Helipots"; synchros and resolvers; computers and counters; colorimeters.

Beckman & Whitley, Inc., San Carlos, Calif. C-515-1
High-speed cameras; meteorological instruments; heat-flow transducers; pressure-transient recorder; guided-missile destructors.

Bendix Aviation Corp., South Bend, Ind. ..... B-444, 445, 446 & 447
"Ultra-Viscoson"; nuclear density gage; nuclear liquid level gage; missile guidance systems; radar; telemetering systems; sonar; digital systems; ultrasonic cleaning.
See ad on page **1245, 1290 & 1305** Circle **69, 135 & 27** on inquiry card.

Benson-Lehner Corp., Los Angeles 64, Calif. ..... A-257 & 258
"Boscar" film analyzer and recorder; oscillograph trace readers; decimal converter; electrotyper; electroplotter.

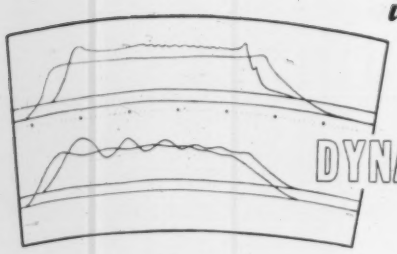
James G. Biddle Co., Phila. 7, Pa. 197-198
Cable fault-locating equipment; corona, transformer-turn-ratio and motor-rotation test sets; ohmmeters; megommeters; tachometers, relays; oscillators; rheostats; carbon piles.

B-I-F Industries Inc., Providence, R. I. A-279
Blenders; proportioning pumps; "Synchro-Scan" remote control; Dall flow tube; "Propeloflo" meter; butterfly valve.

J. Bishop & Co. Platinum Works, Malvern, Pa. ..... A-211 & 212
Tubing 0.008" to 1.000" O.D.; platinum thermocouple wire; platinum and platinum alloys; spinnerettes; electrodes.

Black, Sivalls & Bryson, Inc., Tulsa, Okla. ..... 328, 329 & 330
Automatic pressure and temperature controllers; pilots; relays; control valves.
See ad on **Inside Front Cover** Circle **1** on inquiry card.

Bourns Laboratories, Riverside, Calif. A-266
Potentiometers; pressure and acceleration pickups.
See ad on page **1365** Circle **200** on inquiry card.



instruments for DYNAMATION

- STRAIN GAGE CALIBRATOR
- ELECTRONIC INTEGRATOR
- BRIDGE CALIBRATORS
- D. C. AMPLIFIERS
- PEAK DIGITIZER
- CAMERAS
- RUGGEDIZED AND MINIATURIZED THERMOCOUPLE POTENTIOMETERS

ALINCO

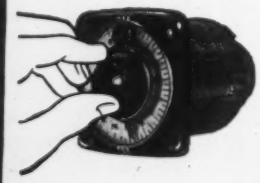
ALLEGANY INSTRUMENT CO., INC.

P. O. BOX 1091 CUMBERLAND, MARYLAND

For more information circle **63** on inquiry card.

low cost
... inventory
... installation
... maintenance

miniature
... for space economy



maximum circuit flexibility
... more than 145 electrical arrangements

An entirely new concept in automatic time interval control, Atcotrol is designed to be the standard in its field.

Requires but one clearance hole for mounting. Atcotrol timer can be demounted from panel in 2 seconds without tools. Completely serviced with a screwdriver. Either reset or stop on power failure. Motor, clutch and reset operation visible from front. Instantaneous reset. No pointer rebound. Built to NEMA standards. Conservatively rated at 10 amps. *Repeat accuracy within .1 of 1%.* Many other new and exclusive features.

Write for complete information.
Trial unit available to o.e.m.'s.
Automatic Temperature Control Company
5224 Pulaski Ave., Philadelphia 44, Pa.
Represented in Canada by: Powerlite Devices, Ltd., Toronto, Montreal and Vancouver.

atc®

ATCOTROL
RESET TIMERS

For more information circle **64** on inquiry card.

EXHIBITORS, PRODUCTS—continued

Booth No.

H. D. Brailford & Co., Inc. A-267
Transistors motor; sub-fractional-watt d-c motor.

The Bristol Co., Waterbury 20, Conn. ..... 399, 400, 401, 402 & 403
Indicating, recording, telemetering and automatic control equipment for temperature, pressure, flow, etc.; electrical instruments.
See ad on page **1182, 1183 & 1275** Circle **12, 114** on inquiry card.

Brooks Rotameter Co., Lansdale, Pa. A-170
Purge meters; rotameters; specific gravity indicator; volumetric calibration system; pneumatic transmitter; control systems.

Brush Electronics Co., Cleveland 14, Ohio ..... B-463 & 464
Industrial & research instruments; direct-writing oscillographs; digital decade counters; "Datacord" tape transport; sound measurement instruments.

Buffalo Meter Co., Buffalo 14, N. Y. B-430
Liquid meters; "Electricontact" meters; "Electrivolume" control system.

Burgess Battery Co., Freeport, Ill. A-174
Dry batteries; power units.

Burgess-Manning Co. ..... (See Penn Instruments Div.)

Burroughs Corp., Paoli, Pa. C-531
"E101" electronic digital computer.
See ad on page **1291** Circle **136** on inquiry card.

Burton Mfg., Co., Los Angeles 64, Calif. 207
Pressure instruments; machmeters; servomotors; blowers, tachometer; dew-point hyrometer.

Byron-Jackson Co., Pasadena 1, Calif. B-307-3
"Vibrotron" digital pressure gage; FM meter; VSWR indicator.

J. A. Campbell Co., Long Beach, Calif. C-512-1
Thermometer wells; boiler feed controls; gage strips; scrubbers.

Central Scientific Co., Chicago 13, Ill. ..... B-452 & 453
Vacuum pumps; beta ray meter; coulometric titrator; vapor equivalent apparatus; constant temperature ovens; laboratory instruments.

Century Geophysical Corp., Tulsa, Okla. ..... B-322 & B323
Oscillographs; bridge control units; dynamic visual monitor; Transducer-amplifier systems.

Chemiquip Co., New York 12, N. Y. A-215
Pressure snubbers; combination mercury trap and surge dampener.

Cinema Engineering Co., Div. Aerovox Corp., Burbank, Calif. A-206
Instrument switches, resistors, attenuators, potentiometers, decade boxes, amplifiers.

CINEMA ENGINEERING CO.
DIVISION AEROVOX CORPORATION
1100 CHESTNUT STREET
BURBANK, CALIFORNIA
PHONE VICTORIA 9-5511
INSTRUMENT COMPONENTS

For more information circle **65** on inquiry card.

Coleman Engineering Co., Inc., Los Angeles 16, Calif. C-501
"Digitizers": Decimal, binary, and binary-coded-decimal analog-to-digital converters; accessories for readout.

Commercial Iron Works, Los Angeles, Calif. C-520-2
Orifice fittings, plates, discs; meter leveling saddles.

Commercial Research Labs., Inc., Detroit 3, Mich. A-128
Flowmeters; flowmeter calibrating stands; viscometers.
See ad on page **1208** Circle **32** on inquiry card.

Conoflow Corp., Philadelphia 3, Pa. 406-407
Pneumatically positioned power operator; "Conomotor" operators; current controllers; control panel; control valves.
See ad on page **1177** Circle **8** on inquiry card.

Consolidated Engineering Corp., Pasadena 15, Calif. ..... A-105, 106, 107, 108, 109 & 110
Infrared gas analyzer; process refractometer; digital voltmeter; bridge balance; electromanometer; pressure and vibration pickups; vibration meters, oscillographs; amplifier systems, mass spectrometers; leak detectors; industrial process control, oscillogram processor; "Evapor-Ion" pump; vacuum instruments.
See ad on page **1213, 1245, 1278, 1302 & 1345**
Circle **33, 68, 117, 149 & 159** on inquiry card.

Continental Equipment Co., Coraopolis, Pa. ..... B-442 & 443
Threaded-end and welding-end small (1 to 3 in.) butterfly valves; standard and heavy butterfly valves.

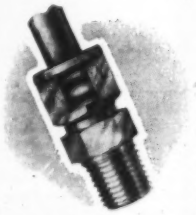
Control Eng'g. Corp., Norwood, Mass. ..... B-348 to B-353
"PHI" unit; "ElectroSyn" transmitters; gyro mass meter; engine pressure indicators; gyros; pendulums; amplifiers; data logging equipment; integrating motors; moving-coil relays.

Control Products, Inc., Harrison, N. J. A-149
Thermal switches; waterproof snap-action switches.

The R. W. Cramer Co., Inc., Centerbrook, Conn. A-143, 144
Automatic time, program and sequence controllers; time meters; timing clutch-unit; chart-drive and dual motors.
See ad on page **1354** Circle **181** on inquiry card.

Crawford Fitting Co., Cleveland 10, Ohio C-521
"Swagelok" tube fittings.
See ad on page **1203**

For Your Convenience—FREE



Swagelok®
Shuttle Bus Service
every 15 minutes between downtown hotels and Shrine Auditorium during ISA Conference & Exhibit
CRAWFORD FITTING CO.
884 East 140th St., Cleveland 10, Ohio

Crosby Steam Gage & Valve Co., Wrentham, Mass. A-163, 164
Safety and bellows relief valves; pneumatic transmitter gage; pressure gages; gage testing equipment.

George W. Dahl Co., Inc., Bristol, R. I. B-306
Hand and diaphragm-operated valves; valve manifolds; manual reset operators; tube or pipe couplings.
See ad on page **1282** Circle **123** on inquiry card.

Daniel Orifice Fitting Co., Los Angeles 23, Calif. ..... 466 & 467
Orifice fittings, flow sections, plates and plate holders; check valves.
See ad on page **1246** Circle **70** on inquiry card.

Daystrom Electric Corp., Poughkeepsie, N. Y. ..... A-251 & 252
Electrical and electronic instruments; magnetic tape recorder.

Daystrom Pacific Corp., Santa Monica, Calif. ..... A-249 & 250
Gyros; intervalometers; potentiometers.

Daystrom Instrument, Archbald, Pa. ..... A-253 & 254
Nuclear reactor control equipment; aircraft instruments; amplifiers; ion chamber; electronic components.
See ad on page **1228** Circle **49** on inquiry card.

The Daven Co., Newark 4, N. J. A-193
Resistors; resistor networks; RC networks, switches; attenuators; vacuum-tube voltmeters; transmission measuring sets.

Davidson Mfg. Co., W. Covina, Calif. C-539
Autocollimators; telescopes; interferometers; precision divided circles; optical components and accessories.

Joe Davidson and Associates, South Gate, Calif. A-151-154
Electric rotary-drive components; associated electronic and electrical equipment.

The Davies Labs., Inc., Riverdale, Md. B-319
Magnetic tape data-recording systems and components.

Dekoron Products Div., Samuel Moore & Co., Mantua, Ohio B-408
Instrument tubing; "Metl-Cor"; "P" ribbon; "EZ" fittings, clips and accessories.

The Detectron Corp., No. Hollywood, Calif. A-232
Electronic frequency counters, timers and countertimers; speed indicators; decade totalizers.

Deutsch Company, Los Angeles, Calif. B-450
Electrical and hydraulic fittings.

DeZurik Shower Co., Sartell, Minn. B-331
Eccentric-type automatic control valve with rubber-faced plugs; control valves.
See ad on page **1247** Circle **75** on inquiry card.

Driver-Harris Co., Harrison, N. J. C-522
"Nichrome"; "NichromeV"; "Advance"; "Manganin"; "Karma"; "Therlo" glass-to-metal sealing alloy.

Driver-Harris
INSTRUMENT ALLOYS
include:
KARMA® NICHROME®
ADVANCE® MANGANIN

For more information circle **67** on inquiry card.

Durant Mfg. Co., Milwaukee, Wisconsin B-477
Electric predetermined counter; contactor-actuator; reset electric counter; tape recorder counter.
See ad on page **1255** Circle **97** on inquiry card.

Eagle Signal Corp., Moline, Ill. A-190
Automatic-reset, predetermined and repeat-cycle timers; reset impulse counters; synchronous control motors.
See ad on page **1361** Circle **192** on inquiry card.

Edin Co., Inc., Worcester, Mass. A-187
Carrier amplifier; stabilized high-gain dc amplifier; oscillographs.

Eastman Kodak Co., Rochester 4, N. Y. A-121
"Linagraph" papers and films; developer and fixer; hypo eliminator.

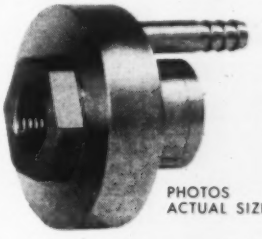
Thomas A. Edison, Inc., Instrument Div., West Orange, N. J. A-276
"Omniguard" monitoring system; temperature detectors; time delay relays; current ratio indicators; thermal switches.

NOW...new accuracy in low-pressure measurement

Accurate enough for precision laboratory measurements, yet sufficiently rugged for in-flight aircraft testing and industrial control use...CEC's new 4-315 *low-pressure* differential pickup. Lightweight (only 60gm) and among the smallest commercial low-pressure pickups available, it is the latest addition to the widely used 4-300 series of resistance-type pressure pickups.

Pressure ranges...±1, ±2, and ±3 psid
Sensitivity...±10 mv f.s.
Excitation...5 v d-c or a-c rms, 0-20 kc
Input/Output Impedance...350 ohms
Linearity...1% f.s. maximum deviation
Hysteresis...less than 1% of f.s.
Acceleration Response...less than 0.13% of full scale per g
Construction...416 stainless steel
Pressure Connection...⅛ npt Internal Thread

A **complete** calibration certificate sent with every unit.



PHOTOS ACTUAL SIZE

Send for pickup Bulletin CEC-1556-X14.

Consolidated Engineering CORPORATION
300 North Sierra Madre Villa, Pasadena 15, California

For more information circle **68** on inquiry card.

ELECTRONIC ENGINEERS

For the expansion of a small group of competent physicists and engineers who are concerned with the development of new devices and with the solution of advanced instrumentation and measurement problems. This group is responsible for devising methods for the solution of special problems and for the experimental verification of these methods. The final engineering and packaging is normally carried out by other groups in the organization. The varied nature* of this work requires both recent graduates and experienced people capable of accepting primary responsibility for the solution of problems of varying degrees of complexity.

Excellent opportunities for advancement and advanced study. Salary commensurate with experience and education level.

*Some of the current investigations are in the fields of mass spectrometry, electron multipliers, electron and ion optics, fast pulse techniques, ultrasonics, radiography, and wide-band sensors for the measurement of pressure, temperature, and flow. For further information please contact:

Personnel Director

BENDIX AVIATION CORPORATION
Research Laboratories Division
4855 Fourth Avenue
Detroit 1, Michigan

For more information circle **69** on inquiry card.

The Electric Auto-Lite Co., Instrument & Gauge Div., Toledo 1, Ohio C-526
Indicating and recording thermometers; pressure and vacuum gauges.
See ad on page **1199** Circle **23** on inquiry card.

ElectroData Corp., Pasadena, Calif. A-111
Magnetic tape units; photos of computers; electronic data processing machines.

Electromec, Inc., Los Angeles 39, Calif. A-226
Multichannel and large-screen oscilloscopes; sweep-frequency generators.

Electronic Associates, Inc., Long Branch, N. J. ..... A-203 & 204
Analog computing equipment; "Variplotter" X-Y recorders.
See ad on page **1306** Circle **154** on inquiry card.

Electronic Tube Corp., Philadelphia 18, Pa. B-469
Multi-gun cathode ray tubes; dual beam oscilloscopes; 4-channel oscilloscope.

Elgin Metalformers, Inc., Elgin, Ill. .....
"Emcor" modular enclosure system (cabinet and console for housing electronic equipment and instruments) for "custom" enclosures with stock components.

Endevco Corp., Pasadena 2, Calif. C-516-4
Acceleration and pressure pickups; amplifiers; analyzers; remote indicating and controlling counters.

The Esterline-Angus Co., Inc., Indianapolis 6, Ind. A-189
Recording electrical instruments; current transformer; contact-making instruments; tachometer generator.

Farnsworth Electronics Co., Fort Wayne 1, Ind. A-234
Closed-circuit TV; radar range calibrator; "Iatron"; infrared viewer; special-purpose tubes.

Farris Eng'g Corp., —Farris Flexible Valve Corp., Palisades Park, N. J. A-280
Safety relief valves; "Super Flex" valves; manual-operated and diaphragm valves.
See ad on page **1170-1171** Circle **5** on inquiry card.

J. W. Fecker, Inc., Pittsburgh 14, Pa. A-235
Optical instruments and elements.

Federal Telephone and Radio Co., Instrument Div.— A Div. of IT&T ..... A-239 & 239½
Resistance, capacitance and inductance bridges; tuned detector amplifiers; precision attenuators; capacitance standards; "Teraohmmeters"; galvanometers.

Microdot Div., Felts Corp., So. Pasadena, Calif. C-516-3
"Microdot" coaxial connectors and cables; "Mininoise" coaxial cables.

Fenwal Inc., Ashland, Mass. ..... A-230 & 231
Thermistor-actuated indicators and controllers; "Thermoswitches"; indicating temperature controllers; turbine thermocouples and harnesses.
See ad on page **1226** Circle **47** on inquiry card.

Fisher Governor Co., Marshalltown, Iowa ..... B-337, 338, 339 & 340
Control-valve topworks; floatless, displacement and probe type liquid-level instruments; pressure regulators; diaphragm motor valves; float valves.

Fischer & Porter Co., Hatboro, Pa. A-177, 178, 179, 180, 217, 218, 219, 220
Electronic flow integrator system; telemetering and supervisory system; digital converters, automatic typewriter, automatic data logger; ultrasonic and standard flowmeters; pressure and temperature instruments; graphic panel with indicating recording, controlling and integrating instruments; chlorinator.

Flexonics Corp., Maywood, Ill. A-216
"Flexon" bellows, expansion joints, flexible metal hose and expansion compensators.

Fluor Corp., Los Angeles 22, Calif. A-168
Pulsation dampeners.

Foster Engineering, Union, N. J. B-431
Flow tubes; control valve; automatic controls for pressure, temperature, liquid level and flow.

The Foxboro Co., Foxboro, Mass. B-305
Vernier "Valvactor" positioner; pneumatic flyball integrator; magnetic flowmeter; d/p cell transmitter; temperature transmitter; "Teletax" telemetering system; industrial indicating, recording and controlling instrumentation.
See ad on page **1192-1193** Circle **18** on inquiry card.

R. P. Gallien & Son, Los Angeles 13, Calif. A-221
Machine tools and hand tools for instrument shops; micro counters and micro decimal weighers; electronic recorder for checking watches and clocks; magnifiers and microscopes.

R. P. GALLIEN & SON

TOOLS & SUPPLIES for

Electronic Assembly
Watch & Gauge Repairing
Jewelers
Opticians
Engravers
Silversmiths
Metal Workers
Die Sinkers
Instrument Makers

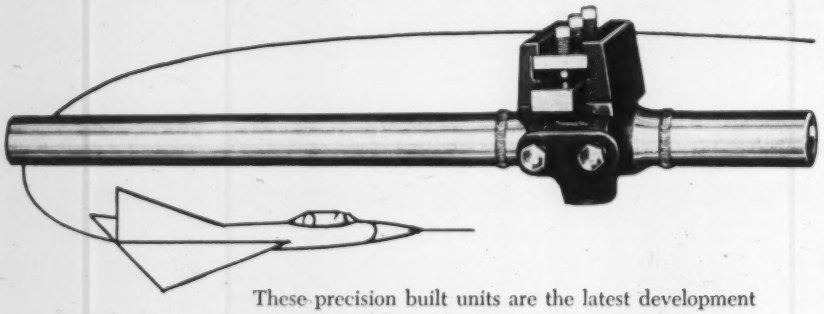
Diamond Tools & Wheels

220 WEST 5TH ST. 2nd FLOOR, LOS ANGELES 13, CALIFORNIA

Phone MUtual 1347

For more information circle **71** on inquiry card.

DANIEL ORIFICE FLOW SECTIONS for MODERN INSTRUMENTATION



These precision built units are the latest development in orifice flow measurement . . . designed by Daniel engineers to meet the critical needs of the aircraft and processing industries. They have found wide application in all phases of research, development and production . . . providing a means for accurate measurement and a fast, safe method of changing orifice plates.

A product of the Daniel Orifice Fitting Company, leaders in the design and manufacture of Orifice Fittings for a quarter of a century.

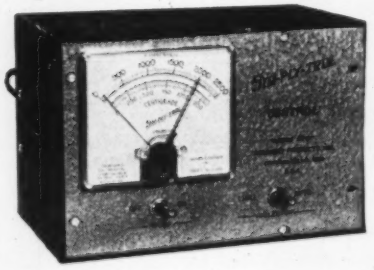
Write for full engineering data on these flow sections. See them at the ISA Show in Los Angeles, Sept. 12-17. Daniel Booth Nos. 466 and 467.

DANIEL ORIFICE FITTING COMPANY

3352 UNION PACIFIC AVENUE LOS ANGELES 23, CALIFORNIA ● **9720 KATY ROAD HOUSTON 24, TEXAS**

For more information circle **70** on inquiry card.

SIMPLYTROL AUTOMATIC PYROMETER



Cat. No. 4531 0/2500° F.
Price $132.00

Thermocouple type Automatic Pyrometer for controlling temperature in furnaces, ovens, and processes. The Simplytrol is economical and reliable with few moving parts. There are no vacuum tubes. The regular load relay is S.P.D.T. 5 Amps. Optional heavy duty relays to 40 Amps.

10 temperature ranges cover from −75° to 3000° F. Several special ranges to −400° F. "On & Off" control for holding the desired temperature works on gas, oil or electric heat. Indicating meter-relay is medium high resistance and has bimetal cold junction compensation. For use with all standard thermocouples. Accuracy 2%.

"Auto-Limit" switch changes Simplytrol from automatic controller to limit pyrometer for safety shut down or warning. Cabinet: 6½x 6½x9½ inches. Also flush panel mount models. Send for new Bulletin G-7 for more data. Assembly Products, Inc., Chesterland 10, Ohio.

Booth 416, WESCON SHOW, Aug. 24-26

For more information circle **72** on inquiry card.

General Controls Co., Glendale 1, Calif. B-482
Industrial automatic controls for temperature, pressure, level and flow control.
See ad on page **1168, 1169** Circle **4** on inquiry card.

General Electric Co., Schenectady, N. Y. B-365, 366, 367
Vibration, speed, radioactivity, and electrical testing instruments; photoelectric recorder; "B" and "PM" thickness gages. Molecular vacuum gage, thermocouple vacuum gage; "H-1" and "M-1" leak detectors; instrument standardizing console. Hand pyrometer; timer and time switches; thermocouple wire; "PM-20" oscillograph.
See ad on pages **1168-1169** Circle **4** on inquiry card.

General Precision Laboratory Inc., Pleasantville, N. Y. B-392 & 393
Industrial TV, accessories and monitors; TV projection system for small theaters, etc.
See ad on page **1180** Circle **10** on inquiry card.

General Precision Equipment Corp., New York 38, N. Y.
..... B-388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398
Refer to listings of—Askania Regulator Co., General Precision Lab., Kearfott Co., Librascope, Inc., Link Aviation, Inc.

General Radio Co., Cambridge 39, Mass. C-515-6
Sweep drives for oscillators and slotted lines; audio-frequency Z-Y bridge; oscillators; square-wave generators.

Genisco, Inc., Los Angeles 64, Calif. ..... B-457 & 458
G-Accelerator; rate-of-turn table; analog-digital recorder; acceleration and pressure pickups.

G. M. Giannini & Co., Pasadena 1, Calif. ..... A-136, 137 & 138
Aerodynamic transducers; pressure transducers; rate gyros; altitude controllers; accelerometers; machmeters; servoed bridge-ratio computer systems. Electromechanical Div.: Switching commutators; pressure switches; shaft positioner; pots; relays; Datex Div.: Digital data-handling systems and components.

Glenco Corp., Metuchen, N. J. .....
Electronic components; packaged R-C circuits.

The Goldak Co., Glendale 1, Calif. A-241
Magnetic amplifiers; airborne and ground survey counters; metal and water leak detectors; strip recorders.

SEE THE NEWEST IN
Magnetic Amplifiers
GOLDAK RELAY AMPLIFIERS ON DISPLAY IN BOOTH A241
***Manufactured by* THE GOLDAK COMPANY**
1544 W. Glenoaks Blvd. • Glendale 1, California

For more information circle **73** on inquiry card.

Goodyear Aircraft Corp., Akron 15, Ohio B-483
Analog computers; "R-5" recorder.

Claud S. Gordon Co., Chicago 16, Ill. C-508
Wire braiding, ISA curves, color coding; "Serv-Rite" wire.
See ad on page **1285** Circle **121** on inquiry card.

Gow-Mac Instrument Co., Madison, N. J. A-268
Gas analyzers; gas chromatography instruments.
See ad on page **1214** Circle **35** on inquiry card.

Greibach Instruments Corp., Metuchen, N. J. .....
Microammeters and millivoltmeters with friction-free movements.

Gulton Mfg. Co., 212 Durham Ave., Metuchen, N. J. .....
Accelerometers; pressure transducers; subminiature amplifiers; connectors; low noise cables.

W. & L. E. Gurley, Troy, N. Y. ..... 424 & 425
Meteorological, hydrographic and surveying instruments; precision patterns on glass; paper testing instruments; binary-to-digital converter.

GURLEY *research development manufacture*
write for booklet **RI**
precision dividing ... reticle facilities ... complete optical shop ... *since* **1845**
W. & L. E. Gurley, Troy, New York

For more information circle **74** on inquiry card.

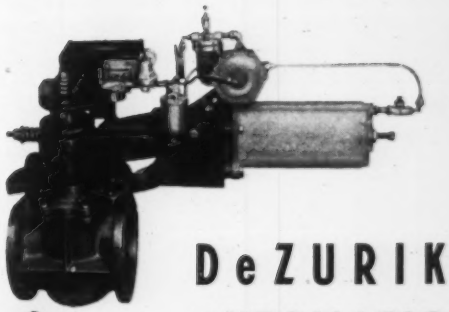
Gyromechanisms, Inc., Halesite, N. Y. C-515-5
Gyroscopes; potentiometers; binocular stabilizer.

Hallikainen Instruments, Berkeley 10, Calif. B-479
Laboratory and industrial plant-stream instruments.

The Hammarlund Mfg. Co., Inc., New York 1, N. Y. ..... A-243 & 244
Remote supervisory controls; telemetering equipment.

Hammel-Dahl Co., Providence 5, R. I. ..... B-421, 422 & 423
"Microflo" control valves; "Ultravalves"; "Dahl" seal; bellows seal; "Flash-Flo" plug; pressure pilot; reducing and relief valves.
See ad on **Back Cover** Circle **219** on inquiry card.

Hamilton Watch Co., Lancaster, Pa. B-325
Special alloys, precision machines parts, timing instruments.



DeZURIK AUTOMATIC CONTROL VALVES

Excellent control characteristics
Unimpeded, straight-thru flow
Sizes from ½" thru 20"
Most castable metals
AND they're attractively priced!

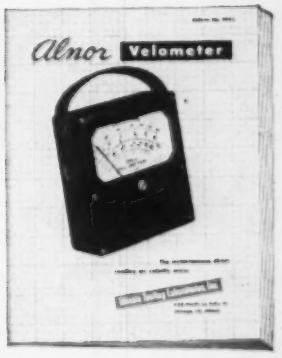
with exclusive eccentric action and resilient plug facing, provide dead-tight shut-off and instantaneous response. They're the ideal valve for controlling liquids, gases, vacuum, granular materials and highly viscous or fibrous suspensions.

See our display at ISA Exhibit—Booth B331

DeZURIK SHOWER CO.
SARTELL, MINNESOTA

For more information circle **75** on inquiry card.

FREE



ILLUSTRATED BULLETIN
How you can save time by measuring air velocities with an
ALNOR VELOMETER

Developed to facilitate quick and easy determination of air velocities, the Alnor Velometer is a compact, precision instrument that provides instantaneous, direct readings in feet per minute, without timing, calculations or reference to conversion tables. Guaranteed accurate, in ranges from 20 f.p.m. to as high as 24,000 f.p.m. Also available with metric or miles-per-hour calibrations.

Tear out this ad and mail it with your business letterhead to Illinois Testing Laboratories, Inc., Room 518, 420 N. LaSalle St., Chicago 10, Ill.

Alnor

PRECISION INSTRUMENTS FOR EVERY INDUSTRY

For more information circle **76** on inquiry card.

Hankison Corp., Pittsburgh 16, Pa. B-411
"Refrigifilter"; "Condensifilter", "Dehydrafilter."

Hathaway Instrument Co., Denver 10, Colo. A-275
Portable strain indicator; strain-gage control unit; 36-channel oscillograph.
See ad on page 1297 Circle 143 on inquiry card.

See the RS-20 Strain Indicator—Booth A275

Hathaway Instrument Company
Subsidiary Hamilton Watch Company
Denver Colorado

For more information circle 77 on inquiry card.

The A. W. Haydon Co., Waterbury 20, Conn. ..... A-129 & 130
Timing motors; automatic timers; elapsed time indicators; intervalometers.

The Hays Corp.—Metrotype Corp., Michigan City, Ind. D-609-Annex
Gas analysis equipment; electronic recorders; flow indicators and controllers; electric and pneumatic transmitters; analog-digital conversion; telemetering load control; numerical recording.

Heath Co., Benton Harbor, Mich. ..... A-255 & 256
Electrical and electronic test instruments and accessories.

Karl Heitz, Inc., New York 17, N. Y. ..... A-286 or 287
Optical and photographic instruments.

ALPA *The Swiss* **ALL-IN-ONE 35 mm Camera**
FOR INDUSTRIAL (close-up, photomicrography)
AND PERSONAL USE

ALPA 4 (straight reflex) from $199.00
ALPA 5, 7 (prism reflex) from $269.00

Reflex through-the-lens focusing allows exact composition with any lens, at any distance
Write for brochure I-8

Karl Heitz, Inc.
High Precision Photo Equipment
Binoculars • Microscopes • Instruments
480 Lexington Avenue, New York 17, N. Y.

For more information circle 78 on inquiry card.

Hickok Electrical Instrument Co., Cleveland 8, Ohio ..... 224 & 225
Stroboflash sound level indicator; laboratory portable test equipment; ruggedized meters; laboratory tube tester.

Hills-McCanna Co., Chicago 18, Ill. .....
"Saunders Patent" diaphragm valves; metering and proportioning pumps.

Hoke Inc., Englewood, N. J. ..... A-270 & 271
Needle, toggle, and packless valves; pressure regulators; "Flo-gages."
See ad on page 1357 Circle 185 on inquiry card.

Hycon Mfg. Co., Pasadena, Calif. C-519-I
Digital voltmeters; oscilloscopes; wave-guide equipment; color-bar generators.
See ad on page 1261 Circle 102 on inquiry card.

Hygrotester, Inc., Brooklyn 1, N. Y. A-298
Portable dielectric moisture tester for instantaneous moisture determination in the paper, pulp and board industries.

Ideal-Aerosmith, Inc., Hawthorne, Calif. C-525
Turn table; roll-pitch-yaw table; barometer-controller; pressure chamber; tachometer tester; needle valves.

IDEAL-AEROSMITH, INC, 12909 S. Cerise Avenue, Hawthorne, California, offers a complete line of precision pressure control instruments including standard and custom made mercurial barometers and manometers. Other standard products include turn tables, combination turn and oscillating tables, roll-pitch-yaw tables, tachometer testers, pressure testers, sensitive needle valves, acceleration limit devices and a wide range of test equipment for varied types of instruments. Facilities for manufacture and servicing of aircraft instruments. Prototype and custom manufacturing service is available for individual specifications. Write for literature and complete information regarding facilities and equipment.

For more information circle 80 on inquiry card.

Illinois Testing Laboratories, Inc., Chicago 10, Ill. ..... A-199 & 200
Pyrometers; resistance thermometers; temperature controllers; air-velocity meters; dew-point meters; thermo-anemometers.
See ad on page 1247 Circle 76 on inquiry card.

Imperial Brass Mfg. Co., Chicago 7, Ill. ..... B-417 & 418
Plastic, brass, and aluminum tubing fittings and tools; indicating valve; disc valve; fluid control valves; test plugs and refacing tools.

NEW MANUAL X-Y PLOTTER KEYBOARD

IMPROVED PERFORMANCE IN SUPPLYING INPUT SIGNALS FOR AUTOMATIC POINT PLOTTERS

A major innovation in this new Librascope manually operated decimal keyboard eliminates sticking switch contacts and high contact resistance. Self-wiping slide-type contacts eliminate necessity for any switch and contact adjustments. Resistance potentiometers are simulated by two voltage dividers—one each for the X and Y axes. All keys are released automatically after point is plotted. A variety of contact configurations available for manual feeding of decimal or binary coded decimal inputs to computer or other systems.

Write for catalog information.

FEATURES

DIMENSIONS—8½" wide; 11" deep; 16" high.

WEIGHT—12 pounds.

POWER—Energized by voltage from recorder. No external source required.

Computers and Controls
LIBRASCOPE
A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

LIBRASCOPE INCORPORATED
1607 FLOWER ST. • GLENDALE, CALIF.

For more information circle 79 on inquiry card.

NORTHAM
DIFFERENTIAL PRESSURE TRANSDUCER

Length: 2½" Weight: 12 oz.

A variable inductance instrument for measurement of differential pressures in ranges ± 200 to ± 5,000 psi and line pressures up to 5,000 psi. Designed for rocket and jet engine testing involving extreme mechanical disturbances, and for general laboratory measurement and industrial control applications.

MODEL DP-15 SPECIFICATIONS:

Pressure Ranges: . . ± 200 to ± 5,000 psid
Maximum Line Pressure: . . . . . 5,000 psi
Accuracy: . . . . . ± 1% full scale
Excitation Frequency: From 60 to 20,000 cps
Natural Frequency: From 2,000 cps to 10,000 cps depending on range
Acceleration Response: Less than 1%/1,000 g along most sensitive axis (range above 1,000 psi)
Less than 1%/1,000 g axial (all ranges)

WRITE FOR BULLETIN NO. IA-15

Northam Engineering Facilities Are Available To Assist You With Any Application Problems.

NORTHAM PRODUCTS INCLUDE . . .
Transducers for pressure, acceleration and displacement measurement and auxiliary electronic equipment for complete systems.

NORTH AMERICAN INSTRUMENTS, INC.
2420 North Lake Avenue • Altadena, Calif.

For more information circle 81 on inquiry card.

Industrial Engineering Corp., Louisville 6, Ky. B-300
"Gage Gards;" Micro Delta P Controllers.

Industrial Instrument Corp., Odessa, Texas B-481
Differential-pressure recorders; pressure transmitters; non-freezing meter bearings; orifice plates and unions.
See ad on page **1343** Circle **157** on inquiry card.

Industrial Timer Corp., Newark 4, N. J. ..... B-459 & 460
Timing devices; interval timers; time delay timers; multi-cam timers; tandem timers; running-time meters.

Industrol Corp., Roselle Park, N. J. ..... C-509 & 510-1
Desiccant-type dryers; desiccant-type filters; desiccants for dehumidification of gases.

Instron Engineering Corp., Quincy 71, Mass. ..... A-125 & 126
Universal testing instrument; tensile tester; integrator and X-Y recorder system.

Instrof, Inc., Philadelphia, Pa. ..... 409 & 410
Metal support troughs and bulkhead bar for instrument tubing.
See ad on page **1276** Circle **115** on inquiry card.

Instruments Publishing Co., Inc., Pittsburgh 12, Pa. B-301
Publications: Instruments & Automation; Instrument & Apparatus News; Instrument Manufacturing. Books: The Automatic Factory; Process Control; Nuclear Reactors for Industry and Research; Electronic Circuitry; and others.

J-B-T Instruments, Inc., New Haven 8, Conn. B-454
Vibrating-reed frequency meters; switches; elapsed-time meters; temperature instruments.

Jensen Instrument Co., Los Angeles 57, Calif. 291
Twin-seal press, diaphragm seals, recording and controlling viscometer, draft gage, U-gage, inclined gage; portable gage with pitot tubes.

Jerguson Gage & Valve Co., Somerville, Mass. ..... A-181 & 182
Remote recording liquid-level gage with warning signals; direct reading level gages; flow glasses; drain, shutoff and flow control valves.

The W. A. Kates Co., Deerfield, Ill. A-120
Pressure and flow regulators with remote air setting and flow-rate indicators.

Kaye Development Co., So. Norwalk, Conn. A-265
Trichrometer; color deviation sets.

Kearfott Company, Inc., Little Falls, N. J. ..... 388 & 389
Electromechanical and electrohydraulic servo systems; analog-to-digital and digital-to-analog converters; position devices, aircraft control systems; microwave components.
See ad on page **1283** Circle **124 & 82** on inquiry card.

KEARFOTT COMPANY, INC.
LITTLE FALLS, N. J.
SALES & ENGINEERING OFFICES
1378 Main Ave., Clifton, N. J.

Servo Systems—Electro Hydraulic and Electro Mechanical.
Servo System Components—Servo Motor, Synchros, Servomotor Tachometer Generators, Servo Amplifiers.
Gyro Systems and Gyros—Compass Systems, Stable Platforms, Vertical, Free, Rate, Floated Rate Integrating.
Precision Ceramics—Bearings, Tool Bits, Insulators.
Transducers—Pressure, Temperature

For more information circle **82** on inquiry card.

Kellogg Switchboard & Supply Co., Chicago 3, Ill. A-119
Crossbar switches; decade counter; relay; connectors, cable; plugs and jacks; cam keys; lights and strip.

The C. M. Kemp Mfg. Co., Baltimore 29, Md. A-246
Air dryers; desiccant dryers; desiccants.

Keystone Tool Co., Houston 5, Texas ..... B-434 & 435
Butterfly valves and ceramic nozzles.

Kieley & Mueller, Inc., Middletown, N. Y. ..... A-261 & 262
Diaphragm motor valves; pressure pilots; displacement-type liquid-level controllers; control valves; regulators and controllers.

Kollmorgen Optical Corp., Northampton, Mass. A-233
Industrial periscopes; projection lenses; rifle 'scopes.
See ad on page **1289** Circle **132** on inquiry card.

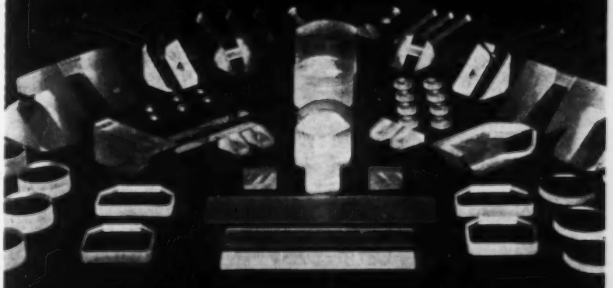
Lapp Insulator Co., Inc., LeRoy, N. Y. B-310
Controlled-volume diaphragm pump with no stuffing box; piston-diaphragm pump; standard pump.

Leeds & Northrup Co., Philadelphia 44, Pa. ..... 385, 386 & 387
Nuclear reactor "package" control system; continuous gas analyzer; infrared analyzer; recorders; controllers; pH indicator; electropneumatic control unit.
See ad on page **1240** Circle **60** on inquiry card.

Leslie Co., Lyndhurst, N. J. ..... A-159 & 160
Pressure-reducing valves; pressure controllers; liquid-level controllers; temperature controllers; pump governors; self-cleaning strainers.
See ad on page **1222** Circle **44** on inquiry card.

Librascope, Inc., Glendale 1, Calif. ..... 394, 395 & 396
Analog-digital converters; X-Y plotter and recorder; X-Y keyboard; punched-tape converter; magnetic read-record heads; magnetic memory drums; transistorized servo-amplifier; totalizing flowmeter; magnetic decision elements.
See ad on page **1248** Circle **79** on inquiry card.

all types of
PRECISION OPTICS
for the manufacturer who must have quality



WM. I. MANN CO.
MONROVIA, CALIFORNIA

For more information circle **83** on inquiry card.

MERCOID®
MERCURY SWITCH EQUIPPED
AUTOMATIC CONTROLS
• FOR PRESSURE •
• TEMPERATURE •
• LIQUID LEVEL •
• MECHANICAL MOVEMENT •

VISIT BOOTH A-208
10th Annual ISA
Instrument-Automation
Conference and Exhibit
September 12-16, 1955
Write for Catalog No. 700B
THE MERCOID CORPORATION
4201 BELMONT AVE., CHICAGO 41, ILLINOIS, U.S.A.

For more information circle **84** on inquiry card.

EXHIBITORS, PRODUCTS—continued

Booth No.

Linde Air Products Co., New York 17, N. Y. B-309
Synthetic sapphire; infrared windows; knife edges; stylii; insulators and spreaders.

Link Aviation, Inc., Binghamton, N. Y. ..... 390 & 391
Interferometric micrometer; cable checkers; phase comparators; speed reducers and adapters for servo-motor mounting.

Liquidometer Corp., Long Island City 1, N. Y. ..... A-201 & 202
Hydraulic and hydrostatic dial-type gages; fuel and position indicators.

Magnetrol, Inc., Chicago 23, Ill. ..... B-426 & 427
Magnetically-operated pilot valves; flow alarm switches; "Magnetrol" liquid controller; pump controls and alarms.

Wm. I. Mann Co., Monrovia, Calif. C-115-4
Optical components; optical comparator; welder; ratio bridge; custom potentiometers.
See ad on page **1249** Circle **83** on inquiry card.

Manning, Maxwell & Moore, Inc., Stratford, Conn. ..... A-245 & 246
Electronic process controller system; pressure gages; mechanical instruments; valves; transmitters.
See ad on page **1220** Circle **42** on inquiry card.

Marquardt Aircraft Co., Van Nuys, Calif. A-205
Ramjet engine developments, accessories.

Marshalltown Manufacturing Co., Marshalltown, Iowa A-214
Pressure gages; vapor-tension-type thermometers; bimetal-type thermometers.
See ad on page **1218** Circle **39** on inquiry card.

Mason-Neilan Regulator Co., Boston 24, Mass. ..... A-139, 140 & 141
Control valves; industrial instruments; level controllers; pneumatic transmitters; valve positioners.

The MB Manufacturing Co., Inc., New Haven 11, Conn. B-343 & 344
Vibration exciters; vibration pickups; vibration meters; engine mounts; isomode pads.

Measurements Corp., Boonton, N. J. A-236
Amplitude modulators; megacycle meters with LF and UHF heads; signal generators.

Meletron Corp., Los Angeles 38, Calif. ..... C-505-1, B-368, 369 & 370
Pressure-actuated, vacuum, altitude and altitude-compensated switches.

The Mercoid Corp., Chicago 41, Ill. A-208
Mercury-switch pressure and temperature controls; liquid-level and sealed mercury contacts.
See ad on page **1249** Circle **84** on inquiry card.

Meriam Instrument Co., Cleveland 2, O. ..... A-171 & 172
Verniers on U-type and well-type manometers; float check valves; micromanometers; "flometers", pressure gages; level gages; barometers.

Micro Switch, Div. Minneapolis-Honeywell, Freeport, Ill. ..... (See Minneapolis-Honeywell listing)

Midwestern Instruments, Tulsa, Okla. ..... B-341 & 342
Oscillographs; galvanometers; magnetic structures; amplifiers; bridge balance units; current sources; data repeaters; servovalves; servo components.
See ad on page **1205** Circle **29** on inquiry card.

Mikron Instruments, Inc., Pasadena 8, Calif. B-456
Auto-collimating telescope.

William Miller Instruments, Inc., Pasadena 8, Calif. B-465
Recording oscillographs; d-c amplifiers; carrier and linear amplifiers; bridge balances; calibrators; analog computers; arbitrary function generators; custom-designed instruments.

Milton Roy Co., Phila. 13, Pa. ..... A-112 & 113
Controlled-volume pumps including "MiniPump"; proportional feed system; pump with automatic stroke adjustment.

Mine Safety Appliance Co., Pittsburgh 8, Pa. ..... A-157 & 158
Water-vapor, thermal-conductivity, combustible-gas, infrared, and oxygen analyzers; portable detection instruments.

Minneapolis-Honeywell Regulator Co., Phila. 44, Pa. ..... B-359, 360, 361, 362, 363, 372, 373, 374, 375 & 376
Recorders and duplex function plotters; pressure and temperature transmitters; differential converter; flowmeters; data-processing systems; motor-operated valves; recording oscillographs; heavy-duty transistors; precision switches.
See ad on page **1166, 1268, & 1269** Circle **3 & 108** on inquiry card.

Moore Products Co., Phila. 24, Pa. ..... A-100, 101 & 102
"Nullmatic" control stations; pressure regulators; relays; thermometers; differential-pressure transmitters; liquid-level controllers, valve positioners.

Morehouse Machine Co., York, Pa. C-514-2
Proving ring; electronic calibrating system; calibrating machine; ring dynamometer.

F. L. Moseley & Co., Pasadena 3, Calif. C-501
X-Y recorder; curve follower; point plotter; IBM card reader; voltmeters.

Mycalex Corp. of America, Clifton, N. J. C-516-2
Glass-bonded mica materials and products; tube sockets; telemetering switches; synthetic mica.

Portable...
Versatile...
Temperature
Test Chamber
For ambient temperature tests in the LABORATORY or on the PRODUCTION LINE, the Model TC-2 Temperature Test Chamber is ideal. Interchangeable extra test trays may be ordered to eliminate loading delays in continuous production tests, or for convenience in special test work.
Range: —65° to + 350° F.
Heater: Electric strip heater
Coolant: Dry ice, 15 lbs. capacity
Control: Adjustable thermostat & selectable heat inputs
Load Capacity: 600 cubic inches of test materials
Power: 115V, 5 amp. 50-60 cycle
Overall Size: 48" x 16½" x 12"
Weight: 62½ lbs.
MODEL TC-2
TEMPERATURE
TEST CHAMBER
$550.00
F.O.B. LOS ANGELES
STATHAM
DEVELOPMENT
CORPORATION
12411 W. Olympic Blvd.
Los Angeles 64, Calif.

For more information circle **85** on inquiry card.

High Precision Optical Components Any Size For Astronomical and Physical Research

•

Parabolic, Spherical, Ellipsoidal and Plane Mirrors

•

Plane Parallel Plates

•

Schlieren Systems

•

Wind Tunnel Optics

•

Lenses & Prisms of Glass Natural or Synthetic Crystals

•

Complete Optical and Mechanical Instruments

•

Made to Specifications

•

High Vacuum Coating

•

John Unertl Optical Co

3551-3555 East Street
Pittsburgh 14, Penna.

For more information circle **86** on inquiry card.

Nash Engineering Co., So. Norwalk, Conn. A-279
Non-lubricated compressors for instrument air supply requiring no oil traps, instrument filters, or after-coolers—large central supply and self-contained package amounts.
See ad on page **1238**

New Hermes Engraving Machine Corp., New York 3, N. Y.
Engraving machines.

North American Aviation, Inc., Downey, Calif.
H-Block electronic modular package; dynamic cushion tester; creep, high-temperature and zero gage length extensometers; high-temperature shear jig.

North American Philips Company, Inc., Mt. Vernon, N. Y. ..... A-281, 282, 283 & 284
X-ray-diffraction equipment; diffractometers; spectrographs; decade scalers and counters; flame photometers; X-ray equipment.

Offner Electronics Inc., Chicago 25, Ill. A-289
"Dynograph" recording oscillographs.
See ad on page **1337** Circle **106** on inquiry card.

Optical Coating Laboratory, Inc., Santa Rosa, Calif. C-516-1
High-vacuum equipment and coating machines; front-surface mirrors; semi-transparent and dichroic mirrors; coated optics.
See ad on page **1251** Circle **87** on inquiry card.

Palmer Thermometers Inc., Cincinnati 12, Ohio A-213
Mercury-in-glass thermometers; dial indicating thermometers; mercury-actuated recording thermometers.
See ad on page **1286** Circle **128** on inquiry card.

Panellit, Inc., Skokie, Ill. A-114-117
Graphic control panels; information system with automatic logging and scanning; annunciator systems; radiation detection equipment, and remote area monitoring system.
See ad on page **1225**

Penberthy Injector Co., Detroit, Mich. B-432, 433
Liquid level gages; ejectors; sump pumps.

Penn Instruments, Div. Burgess-Manning Co., Phila. 4, Pa. C-512-2
Orifice plates and piping assemblies; flow nozzles; Venturi tubes; flowmeters; recorders and air-operated controllers; area meters; controller and valve positioners; pneumatic transmitters; mass flowmeters.
See ad on page **1188 & 1189** Circle **16** on inquiry card.

Perkin Engineering Corp., El Segundo, Calif. A-297
Laboratory power supplies; a-c line regulators.

The Perkin-Elmer Corp., Norwalk, Conn. C-520
Vapor fractometer; process control analyzers.

Perlmuth-Colman Instrumentation, Los Angeles 7, Calif. A-209 & 210
Manufacturers' representatives.

The Permutit Co., Ranarex Div., New York 36, N. Y. A-142
Gas analyzers and controllers.

Phillips Control Corp., Joliet, Ill. B-320
Relays; actuators.

Photocon Research Products, Pasadena, Calif. A-272
"Dynagage" microphones and pressure transducers; direct-coupled amplifier for galvanometer oscillographs; telemetering counters; spark protractors; lite gages and metroscopes.

Potter Aeronautical Co., Union, N. J. ..... B-326 & 327
Turbine-type flow-sensing elements; flow indicators and controllers; mass flow meters; flow telemetering; density detector units; predetermining and computing counters; air-speed indicators; tachometers.
See ad on page **1127** Circle **48** on inquiry card.

Precision Coil Spring Co., Los Angeles, Calif. A-213
Custom-made precision springs (wire, 0.010 and 0.148 diam.).

Precision Thermometer & Instrument Co., Phila. 30, Pa. B-318
"Densitrol" magna-set thermoregulator; thermometers; dial thermometers; thermostats.

Precision Scientific Co., Chicago 47, Ill. ..... 515-2 & 515-3
Automatic Reid vapor pressure apparatus; loading rack flash tester; automatic distillation apparatus; recordomatic titrometer.

Radiation, Inc., Melbourne, Fla. C-507-1
Telemetering transmitter; recorders; servometer; regulated voltage-current, and voltage standards; coaxial attenuator; wavemeter.

Radio Frequency Laboratories, Inc., Boonton, N. J. ..... B-311 & 312
Data transmission terminals; instrument calibration stand; magnet charging and magnet treating equipment; chassis slides; switches and handles for portable cases.

I. B. Rea Company, Inc., Santa Monica, Calif. 412
Analog-to-digital converter; "Readix" general-purpose computer.

Republic Manufacturing Co., Cleveland 2, Ohio ..... A-227 & 228
Needle valves; bleeder valves; globe valves; check valves; relief valves; plug valves; strainers and aircraft units.

Research Controls, Tulsa, Okla. C-134
Die-cast valves; specialty valves; tantalum plugs; super-pressure valves; pneumatic motors; small flow and pH control valves.

Revere Corp. of America, Wallingford, Conn. A-118
Fluid flow switches; fluid float switches; "glaswitch", electronic weighing cells; thermocouple wires; thermocouples and harnesses.

Robertshaw-Fulton Controls Co., Fielden Instrument Div., Phila. 33, Pa. ..... B-412 & 413
Scanners; capacitance equipment; proximity meters; multipoint recorders; "Tektor" capacity level controls; "Telstor" continuous level indicators; amplifiers, current controllers; pyrometers; platinum bulbs.
See ad on page **1259** Circle **100** on inquiry card.

Robertshaw-Fulton Controls Co., Fulton Sylphon Div., Knoxville 1, Tenn. ..... B-414, 415 & 416
Temperature and pressure controls; valves; "Fulton" pilot controllers; thermostats; bellows assemblies; expansion joints; bellows motor valves.

You are cordially invited
to visit
our exhibit of
OPTICAL COATING PROCESSES & PRODUCTS
in Booth C-516
I. S. A. Exposition

Our technicians will be on hand
to discuss
your coating problems with you.

•

Numerous types of unusual
and standard coatings will be
displayed for your inspection.

•

A modern high vacuum coating
machine will be in operation.

OPTICAL COATING LABORATORY, INC.
Santa Rosa, California
Manufacturing Branch
ORANGE, CALIF.

For more information circle **87** on inquiry card.

Ametron® ELECTRONIC CRANE SCALE

Weighs heavy loads suspended from crane hook. Printer, located in crane cab or other convenient location, records weight on tape or cards. New compact printer only 22" x 18" x 10½".

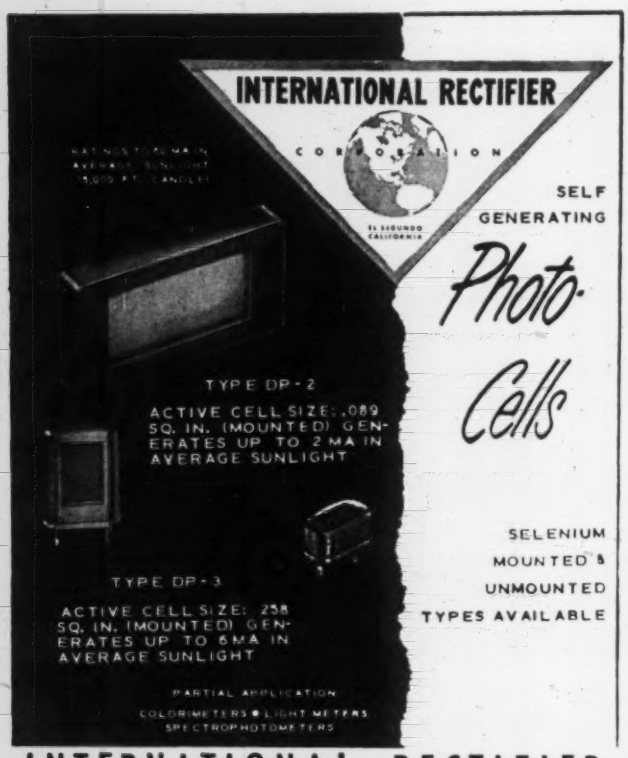
Entire assembly designed for prompt and easy installation. Now available at new low cost. Capacities 5 10 15 tons

Write for free Ametron Brochure K-5

STREETER-AMET CO.
4101 N. RAVENSWOOD AVENUE
CHICAGO 13, ILLINOIS
Branches in Detroit, Pittsburgh, Allentown, Birmingham and Los Angeles

THE STANDARD OF ACCURACY SINCE 1888

For more information circle **88** on inquiry card.


INTERNATIONAL RECTIFIER
CORPORATION
EL SEGUNDO CALIFORNIA
SELF GENERATING
Photo-Cells
TYPE DP-2
ACTIVE CELL SIZE: .089 SQ. IN. (MOUNTED) GENERATES UP TO 2 MA IN AVERAGE SUNLIGHT
TYPE DP-3
ACTIVE CELL SIZE: .258 SQ. IN. (MOUNTED) GENERATES UP TO 6 MA IN AVERAGE SUNLIGHT
SELENIUM MOUNTED & UNMOUNTED TYPES AVAILABLE
PARTIAL APPLICATION
COLORIMETERS • LIGHT METERS
SPECTROPHOTOMETERS

INTERNATIONAL RECTIFIER CORPORATION

1521 E. Grand Ave., El Segundo, Calif • Phone: ORegon 8-6281
CHICAGO: 205 W. Wacker Drive • Phone: Franklin 2-3889
NEW YORK: 501 Madison Avenue • Phone: Plaza 5-8665

For more information circle **89** on inquiry card.

"COSTS CUT 60¢ per hour per machine"

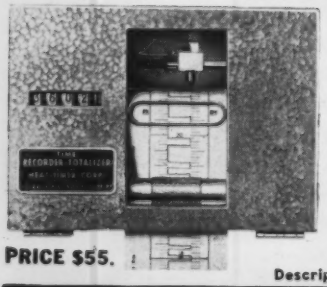
"... simplified our time study and cost analysis."

"... and, we will install your units on all our machines."

"... meets all our requirements. Ship 35 more units at once."

—just a few of the many comments we receive daily about...

TIME RECORDER-TOTALIZER



• This precision instrument provides accurate, permanent, chronological data about any machine, process or system in plant or office ...on a continuous chart-roll which lasts four months. Uses no ink. Totalizer shows accumulated "on" time.

PRICE $55.

Descriptive Literature IA on Request

RECORDER DIVISION
HEAT-TIMER corporation
657 BROADWAY, NEW YORK 12, N.Y.

For more information circle **90** on inquiry card.

Booth No.

Robinson Orifice Fitting Co., Los Angeles 23, Calif. A-135
Orifice fittings; meter runs; blind valves; orifice plates; straightening vanes.

SCAM Instrument Corp., Chicago 18, Ill. A-290
Annunciators; alarm systems.
See ad on page **1358** Circle **186** on inquiry card.

Servo-Tek Products Co., Inc. Hawthorne, N. J. ..... A-155 & 156
D-c tachometer generators; permanent-magnet motors; electronically-controlled d-c motor generators.

Shallcross Manufacturing Co., Collingdale, Pa. B-480
Resistors; switches; attenuators; delay lines; bridges; galvanometers; low-resistance test sets.
See ad on page **1257** Circle **98** on inquiry card.

Shand & Jurs Co., Berkeley 10, Calif. ..... B-302 & 303
Remote-reading automatic tank gages.

Skinner Electric Valve Div., Skinner Chuck Co., New Britain, Conn. B-313
Solenoid valves.

S. Morgan Smith Co., York, Pa. 222, 223, 224, 225
Butterfly, roto, non-lubricated valves; poppet-type safety valves.

T. Louis Snitzer, Los Angeles 19, Calif. A-269
Power supplies; precision potentiometers; pulse generators; electrometers; oscilloscopes; spectrum analyzers; transistor analyzers.

Southwestern Industrial Electronics Co., Houston 19, Texas C-530
Direct-reading flowmeter computing systems; magnetic recording equipment; cathode-ray oscilloscopes; voltmeters; oscillators; resistance meters; bridges; amplifiers; computers; geophysical and vibration analysis equipment.
See ad on page **1355** Circle **184** on inquiry card.

The Special Screw Products Co., Bedford, Ohio B-324
"Koncentrik" fittings; heavy-duty screwed unions; lap-joint stub ends.

Statham Laboratories, Inc., Los Angeles 64, Calif. A-147
Accelerometers; pressure transducers; force and displacement transducers.
See ad on page **1264** Circle **104** on inquiry card.

Streeter-Amet Co., Chicago 13, Ill. ..... A-215 & 216
Data printers; pulse counters; analog-to-digital converters; electrical weighing equipment.
See ad on page **1251** Circle **88** on inquiry card.

Stroud Enterprises, Los Angeles, Calif. C-503
Counters; motors; transducers; pots; choppers; pressure switches.

The Superior Electric Co., Bristol, Conn. ..... A-292 & 293
Variable-transformers; voltage regulators; "Luxtrol" light controls.

Superior Tube Co., Norristown, Pa. C-519
Bourdon, capillary, needle, hydraulic, super pressure and mechanical tubing.

Surprenant Mfg. Co., Boston 8, Mass.
Insulated wire, cable, and insulation for electronics and aircraft industries. Miniature Teflon coaxial cables; extruded Teflon and Kel-F insulated wire; low temperature tubing and jackets; high temperature hook-up wires; wires for miniaturization for electronic and aircraft industry.

Swartwout Co., Cleveland 12, Ohio B-481
"Autronic" components; complete panel ready for installation.
See ad on page **1173, 1174, 1175 & 1176** Circle **7** on inquiry card.

Swiss American Jewel Bearing Co., Woodside 77, N. Y. A-124
Jewel bearings, precision screw machine products.

Swissomatic Products, Santa Monica, Calif. ..... B-315, 316 & 317
Swiss automatic screw machine.

Taylor Instrument Cos., Rochester 1, N. Y. ..... 436, 437 & 438
Complete line of indicating, recording and control instruments for graphic and conventional panels; time program controller; dp transmitter.

Technical Charts Inc., Buffalo 10, N. Y. ..... A-157 & 158
Circular, strip and rectangular charts for recording instruments.

Tektronix, Inc., Portland 7, Ore. ..... B-461 & 462
Plug-in preamplifier oscilloscopes; portable oscilloscopes; vacuum-tube characteristic-curve tracers; time-mark generators.

Tenney Engineering, Inc., Union, N. J. A-173
Temperature-humidity test chambers; "hi-lo" test chambers.

Thermistor Corp. of America, Metuchen, N. J.
Wafer and other types of temperature sensitive resistors (thermistors).

Thermo Electric Co., Inc., Rochelle Pk. P. O., N. J. ..... B-404 & 405
Temperature monitoring systems; pyrometer controllers; balance indicators; recording controllers; thermocouples; thermocouple wires; connector panels; quick-coupling connectors.
See ad on page **1359** Circle **188** on inquiry card.

Tracerlab, Inc., Boston 10, Mass. ..... 354 & 355
Radiation research and laboratory instruments; sulphur determination apparatus; liquid level gage.

Traid Corp., Bell & Howell Co., Sherman Oaks, Calif. C-534
Recording and high-speed cameras; film analyzer; boresight and timing systems; lenses and accessories.

Trinity Equipment Corp., Roselle Park, N. J. ..... C-509 & 510-1
Thermowells; thermocouples and assemblies; hydrogen corrosion detection probes.

64 pages!

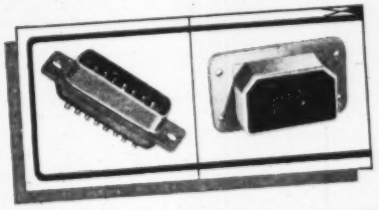
New Material on

CANNON

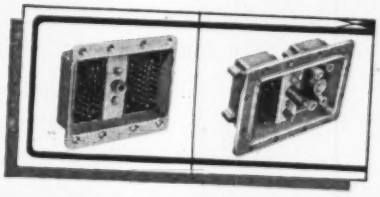
Rack-Panel-Chassis

CONNECTORS

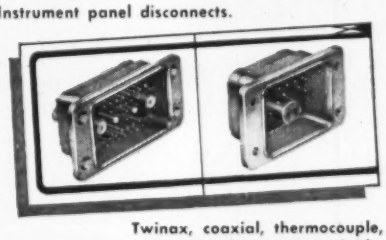
THE MOST COMPLETE LINE AVAILABLE



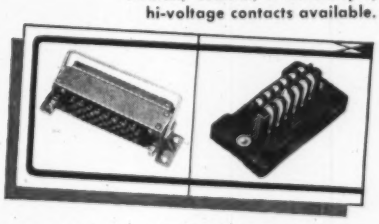
Steel-shell sub-miniatures in 4 sizes, 15 to 50 five-amp. contacts. Hermetic seal pin side also available. Aluminum-shell miniatures in two sizes, 9 inserts.



Instrument panel disconnects.



Twinax, coaxial, thermocouple, hi-voltage contacts available.



For use in close or cramped quarters. Radio terminal connectors, right, have no shell, designed for quick-disconnect on radio chassis.

Cannon DP-RTC rectangular connectors range all the way from sub-miniature to standard size units . . . meet every need where space is a problem.

Insulators are designed for strength, lightness and high dielectric qualities. Contacts are copper alloy, precision machined from solid bar stock for perfect fit. Socket contacts, wherever size permits (except RTC leaf type), use closed-entry construction to prevent spreading that might be caused by over-sized contacts or test probes.

Write for New DP9 Bulletin—a new kind of engineering bulletin. Please refer to Dept. 180

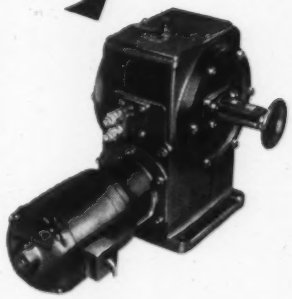
CANNON PLUGS

CANNON ELECTRIC CO., 3209 Humboldt St., Los Angeles 31, Cal.

For more information circle **91** on inquiry card.

A portion of the 200 acre scale model of the Mississippi Basin, shows one of the Askania Controls used in this flood control study.

Huge 200 acre experiment needs PRECISE CONTROL!



The Askania Unit Regulator, a completely self-contained automatic control. This versatile unit, one of an extensive line, finds its widest use in applications where measured signals are low level and power requirements at the point of control are moderate.

"See us at Booth Nos. 601-603, First International Instrument Congress & Exposition, September 13-24, 1954"

The Corps of Engineers, U. S. Army uses a 200 acre scale model of the Mississippi Basin in flood control studies that may eventually solve that area's flood control problem. In the studies, six standard Askania Controllers were used to assist in precisely simulating the behavior of one of the world's mightiest river systems.

While flood control may not be your problem, precise, sensitive, and powerful Askania controls may be the solution to your control problems. These units are currently solving problems in the metal, glass, plastic, rubber, textile and paper processing industries. If you have control problems that are boosting your costs or lowering your product quality, investigate these Askania Controllers.

Write for Bulletins 139 and 155.

ASKANIA REGULATOR COMPANY

290 E. Ontario Street, Chicago 11, Illinois

Subsidiary of General Precision Equipment Corp.

For more information circle **92** on inquiry card.

Booth No.

Unistrut Products Co., Chicago 7, Ill. ..... A-145 & 146
Adjustable metal framing; tubing and piping racks.

VISIT BOOTHS A-145 and 146 FOR . . .

new type laboratory furniture, work bench, support units for tubing, piping, electric and gas lines . . . with UNISTRUT adjustable Metal Framing.

Unistrut Products Company
1015 Washington Boulevard
Chicago 7, Illinois

For more information circle **93** on inquiry card.

United Electric Controls Co., Watertown 72, Mass. B-304
Temperature and pressure controllers.

Unitek Corp., Pasadena 8, Calif. C-535
Bench-type, tweezer-type and heavy-duty welders.

U. S. Electrical Motors, Inc., Los Angeles 54, Calif. C-542
"Varidrive" motors; "Varitrol" controls.

U. S. Engineering Co., Glendale, Calif. A-263
Electronic hardware; printed circuitry.

United States Gauge Division of American Machine and Metals, Inc., Sellersville, Pa. ..... B-470, 471, 472 & 473
Pilot controllers; gages featuring rotary movements; receiving gages; gages and instruments.
See ad on page **1255** Circle **96** on inquiry card.

The Vapor Recovery Systems Co., Compton 1, Calif. 356, 357 & 358
Pulse-code telemetering systems; electronic gaging equipment; automatic tank gages.
See ad on page **1363** Circle **196** on inquiry card.

Varian Associates, Palo Alto, Calif. ..... A-191 & 192
E-p-r and N-m-r spectrometers; laboratory magnet systems; graphic recorders.

G. H. Vaughan Co., Pasadena 1, Calif. A-268
Gas analyzers; pressure pickups; accelerometers; position indicators; carrier systems.

Booth No.

Veeder-Root Inc., Hartford 2, Conn. ..... B-428 & 429
Counters
See ad on page **1234** Circle **55** on inquiry card.

Vibro-Ceramics Corp., Metuchen, N. J.
Ultrasonic drills; soldering irons; generators; attenuation analyzers.

Wallace & Tiernan Inc., Belleville 9, N. J. ..... B-474, 475 & 476
Flow measuring, surveying, and pressure-recording instruments.
See ad on page **1215** Circle **36** on inquiry card.

Warren Electronics, Inc., Bound Brook, N. J. C-504
"Spectracord" spectrophotometer recorder for ultraviolet, visual and near-infrared spectroscopy.
See ad on page **1298** Circle **144** on inquiry card.

Waterman Products Co., Inc., Philadelphia 25, Pa. A-295
Oscilloscopes; "Pocketscopes"; "Pulsescopes"; "Rakscopes"; cathode-ray tubes.
See ad on page **1190 & 1191** Circle **17** on inquiry card.

Waugh Engineering Co., Van Nuys, Calif. A-148
Airborne and industrial flow measuring systems; high-frequency pulse-rate converters.

SEE IMPORTANT NEW DEVELOPMENTS IN *TURBINE FLOWMETERS*
BOOTH A148
WAUGH ENGINEERING COMPANY
FLUID FLOW MEASURING EQUIPMENT

For more information circle **95** on inquiry card.

Weatherhead Co., Ft. Wayne Div., Ft. Wayne, Ind. B-332, 333
Industrial brass, and "Ermeto" steel and stainless steel tube fittings.

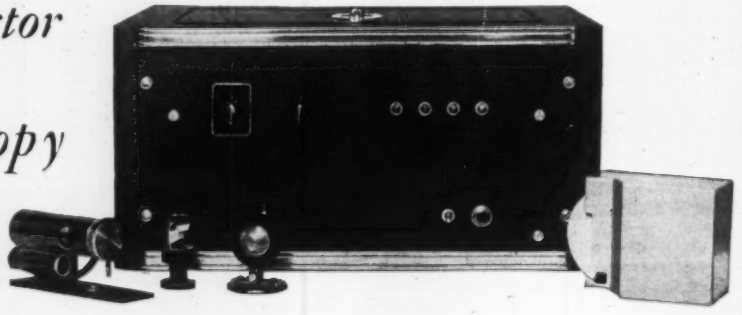
W. M. Welch Manufacturing Co., Chicago 10, Ill. A-294
"Densichron" integrating timers; photometers; densitometers; monochromoters; "Duo-seal" vacuum pumps; laboratory scales.

West Instrument Corp., Chicago 22, Ill. ..... B-448 & 449
Temperature measuring and control equipment; controllers; recorders; pyrometers and accessory equipment.
See ad on page **1290** Circle **134** on inquiry card.

Westberg Manufacturing Co., Napa, Calif. A-274
Electric tachometers; engine test equipment; wind speed and direction indicators; moisture meters.

Western Control Equipment Co., Sherman Oaks, Calif. B-314
Manufacturers representatives.

A Superior Detector
for
Infra-Red Spectroscopy



GOLAY PNEUMATIC DETECTOR

Among the characteristics that render the Golay Detector superior to other types of detectors for use in infrared spectroscopy are:

1. **An effective sensitive area 3/32" in diameter.**
2. **Sensitivity of 6 x 10^{-11} watts RMSENI when used with "chopped beam" method and with recording time constant of 1.6 second.**
3. **Uniform sensitivity from the ultra-violet through the visible and the entire infra-red, and up to the micro-wave region.**
4. **Improved, drift-free, A.C. operated amplifier with step gain controls and four response periods.**

Write for EPLAB Bulletin No. 10

THE EPPLEY LABORATORY, INC.
SCIENTIFIC INSTRUMENTS
2 SHEFFIELD AVENUE, NEWPORT, RHODE ISLAND, U.S.A.

For more information circle **94** on inquiry card.

Booth No.

Weston Electrical Instruments Corp., Newark 5, N. J. .....247 & 248
Recorders; controllers; relays; tachometers; thermometers; "Inductronic System" for measurement and control.
See ad on page 1239 Circle **59** on inquiry card.

Wheelco Instruments Div., Barber-Colman Co., Rockford, Ill. A-169
Potentiometer-type recorder; non-indicating potentiometer controller.
See ad on page 1277 Circle **116** on inquiry card.

Wiancko Engineering Co., Pasadena 8, Calif. .....439, 440 & 441
Data-reduction equipment; airborne instrumentation; pressure, force, acceleration and position pickups; carrier equipment; packaged instrumentation systems.

Wright Engineering Co., Pasadena 1, Calif. .....C-516-5 & 516-6
Plotting equipment; power supplies; shaft angle digitizers; resistance bridges; servo motors; servo amplifiers; cameras; telemetering oscillators; strain-gage digitizers; voltage dividers; magnetic-core memories; character displayers.

Just published . . .

THE AUTOMATIC FACTORY

—a critical examination

by Stephen A. June, J. D. Bandis, L. H. Lurio, L. S. Polaner, O. Sagedahl, H. A. Sklenar and B. K. Yenken.

Cloth; 88 pages + viii; 5½ x 8¼"; subject index; illustrations.

$1.50 postpaid

THE INSTRUMENTS PUBLISHING CO.
845 Ridge Ave. Pittsburgh 12, Pa.

NEW! USG

SUPERGAUGE®

with exclusive ARC-LOC MOVEMENT

- With proper application this new Supergauge will last a lifetime!
- Legend on dial gives complete description of gauge construction. Maintenance engineer can pick proper gauge from his stock.
- Nylon-faced stainless steel segment with stainless steel pinion and stainless bushed bearings give lifetime service!
- *For your convenience* MONO-UNIT CONSTRUCTION Permits easy removal of complete gauge assembly for inspection and adjustment. ARC-LOC MOVEMENT Provides complete and rapid adjustment from rear without removal of dial.

MICROMETER ADJUSTABLE SELF-LOCKING POINTER

Above features are also available in USG Solfrunt Gauges with solid front construction.

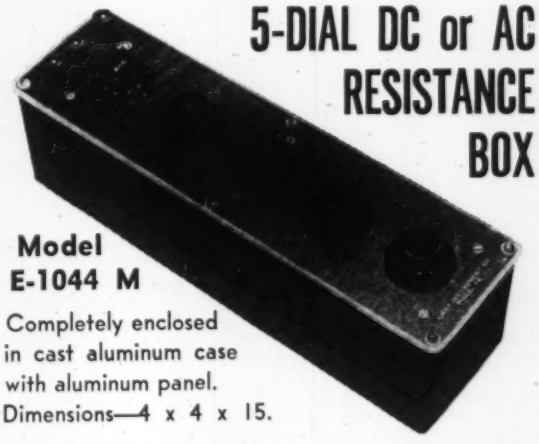
See our Booth Nos. B470-B473 at the Instrument Show.

UNITED STATES GAUGE USG *Gauge Headquarters* for over 50 years

United States Gauge, Division of American Machine and Metals, Inc., Sellersville, Penna.

For more information circle **96** on inquiry card.

5-DIAL DC or AC RESISTANCE BOX



Model E-1044 M

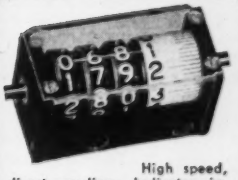
Completely enclosed in cast aluminum case with aluminum panel. Dimensions—4 x 4 x 15.

- 3 Universal Binding Posts . . . one for ground connection
- Various Ranges. Each decade gives 10 steps plus zero position. Positive Detent Action
- Zero Resistance—0.0025 ohms per decade
- Accuracy above 0.1 ohm .05%, on 0.1 ohm, 0.1% maintained well above audio frequency range. Low temperature coefficient of resistance.

Send for our catalog of precision standard resistors, resistance bridges, and potentiometers

GRAY INSTRUMENT COMPANY
64 West Johnson Street, Philadelphia 44, Penna.

For more information circle **222** on inquiry card.



High speed, direct reading. Indicates increment of measurement in radar navigation instruments.

"Y" Rotary Counter used in navigating instruments.

DURANT Specials
For RADAR • ELECTRONIC • INSTRUMENT Applications

Special counter for Tapo Recorder to indicate position of tape passing through recorder.

Special high speed Y-type for Goniometer application.

Send for Literature

DURANT MANUFACTURING CO.
1914 N. Buffum St. Milwaukee 1, Wis.
114 S. Water St. Providence 3, R. I.
Representatives in Principal Cities

PRODUCTIMETERS BOOTH B-477
Count Everything

For more information circle **97** on inquiry card.

New Instruments...

INSTRUMENTS and AUTOMATION

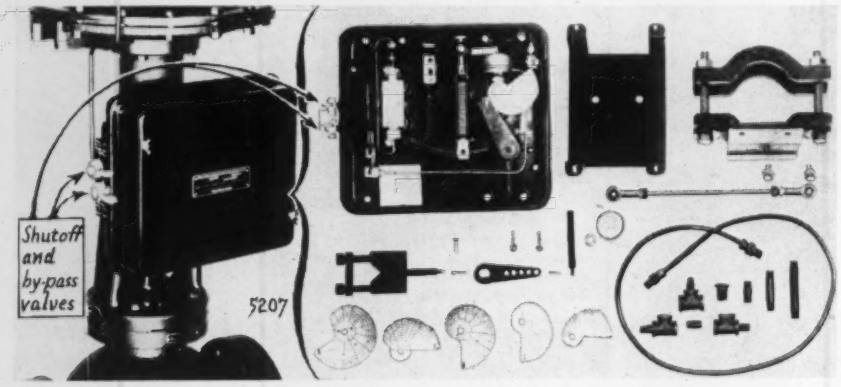
For further information use the postage-free order card on page 1373

PROCESS CONTROL and MONITORING

Close-control Positioner Kit for Field Application

New "Positioning Relay Kit" for field application to any air-operated control valve obeys standard 3-15 psig or 3-27 psig commands; utilizes a force-balance mechanism whereby 0.065 psig input change will apply full output (50 psig max) to valve motor; comes with six pre-shaped (and further "field-shapeable") cams. Its supply and by-pass air valves can be locked in place.—*Bailey Meter Co., 1050 Ivanhoe Road, Cleveland 10, Ohio.*

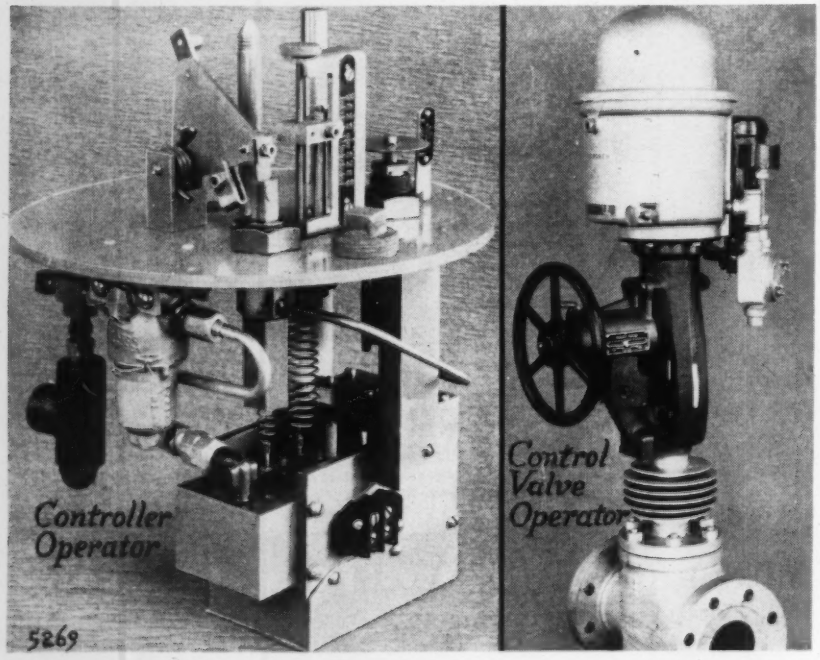
For more information circle **301** on inquiry card.



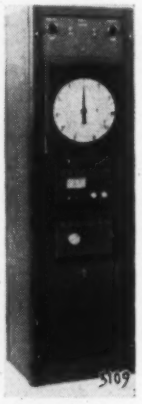
Automatic Control Mechanisms

New self-contained "Electro-Hydraulic Control Valve Operator" obviates need for air supply and compressor systems: uses hydraulic force developed by self-contained pumping unit powered from 115 or 230 volt supply. Positioning accuracy is established by a self-contained feedback system. Operator obeys 0.5-to-5.0-ma dc signals of maker's "American-Microsen" transmission and control systems. These signals include proportioning, reset and rate actions. ★ New "Electro-Hydraulic Controller-Operator" is a modification of "Control Valve Operator" incorporating proportional and reset control actions, operated directly from a transmitter. Speed of response is such that phase lag is less than 60° at 1 cps when set for ½-in. stroke.—*Manning, Maxwell & Moore, Inc., Industrial Controls Division, Stratford, Conn.*

For more information circle **302** on inquiry card.



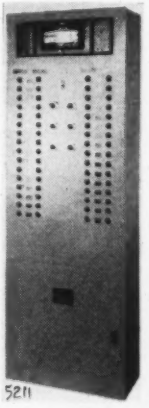
pH Control Systems



New "packaged" pH control systems combine all components needed for single or multiple-channel pH process monitoring, recording and controlling. Each system is factory-wired, piped and assembled ready for plug-in installation. Basic components can be assembled into a number of different combinations from simple pH meter and alarm to multiple-channel monitor-recorder-alarm control system.—*Beckman Instruments, Inc., Fullerton 1, Calif.*

For more information circle **303** on inquiry card.

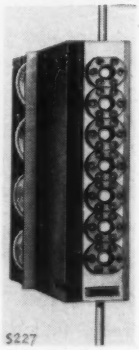
Automatic Monitor



New "Control Center" obviates need of individual instruments for automatically checking multiple temperatures in process work; is of scanner type, comprises "Model 245P Multronic Capacitrol," pilot lights, pulse-actuated stepping switch, pulsing timer and holding relays. It automatically checks temperatures in rotation (e.g. 32 stations in two minutes). A pilot light indicates point being checked. Should any station be off limits, visual and audible alarm is given; amount of correction needed is indicated by "Model 245" instrument. A manual reset switch clears alarm indication after temperature corrections have been made; another switch is for manually checking any point at will.—*Wheelco Instruments Div., Barber-Colman Co., 1300 Rock St., Rockford, Illinois.*

For more information circle **304** on inquiry card.

Liquid Level Gage



New model of maker's "Multi-Port Bi-Color Gauge" is available with end stems so that it can be used to replace other gages on existing boilers. Small round ports with easily-replaced inexpensive and individual mica, glass and gasket elements permit maintenance to be done in place without removing gage from boiler.—*Diamond Power Specialties Corp., Lancaster, Ohio.*

For more information circle **305** on inquiry card.

CONTENTS OF THIS DEPARTMENT

Process Control	1256	Electr. Instruments	1280
Machine Automation	1260	Electrical Testing	1283
Dimensional Gaging and Inspection	1262	Electr-instrument Accessories	1284
Mechanical Tests	1264	Electrical and Electronic Components	1288
Laboratory Equipment	1266	Electromechanical Components	1291
Nucleonics	1273	Mechanical Components	1296
Counting Computing	1274	Valves	1299
Time and Speed	1277	Miscellaneous	1300

Pressure Controller

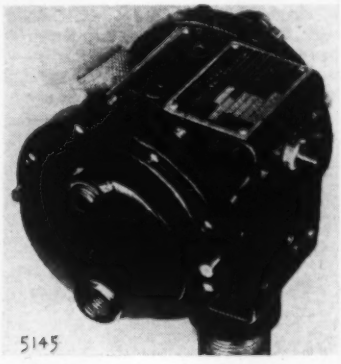
New pneumatic pressure controller is housed in a small (11x11x4 in) splashproof die-cast aluminum case

permitting interchangeable flush or surface mounting on panels of any thickness; features on-off or 10% proportional control action. Measuring-system spiral can be connected at back or bottom of case. Range 0 to 200 psi. Accuracy 1% of full span.—*Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.*

For more information circle **306** on inquiry card.

D/p Transmitter

New differential-pressure flowmeter body measures 4x5 in, weighs 10 lbs, is a scaled-down version of maker's "Model 700." Among features: seam-



less stainless-steel or Monel bellows; free-floating non-freezing stainless-steel bearing; pulsation damping adjustable in operation; ambient-temperature compensation; over-range protection to housing's pressure rating.—*Industrial Instrument Corp., Odessa, Tex.*

For more information circle **307** on inquiry card.

Level Controllers

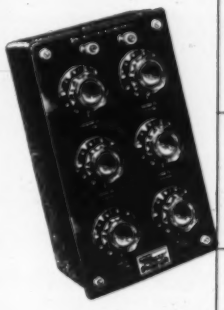
Three new variations of maker's "Tektor" level and flow detector and controller are "tube-in-probe" Tek-

DECADE RESISTANCES & VOLTAGE DIVIDERS

delivered from stock

Accuracy: 10 ohms and above: ±0.1%
1 ohm: ±0.25%
0.1 ohm: ±1%
0.01 ohm: ±5%

Temp. Coeff.: ±0.002% per degree C.
Maximum Load: ½-watt per step
Frequency Limit: Non-inductive to 20KC

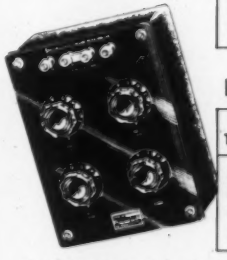


DECADE RESISTANCE BOXES

Type	Dials	Ohm Steps	Total Resistance—Ohms	Price
817	3	0.01	11.1	$60.00
818	3	0.1	111	51.00
820	3	1	1,110	56.00
821	3	10	11,100	60.00
822	3	100	111,000	63.00
823	3	1,000	1,110,000	77.00
824	3	10,000	11,100,000	120.00
817-A	4	0.01	111.1	75.00
819	4	0.1	1,111	71.00
825	4	1	11,110	77.00
826	4	10	111,100	79.00
827	4	100	1,111,000	92.00
828	4	1,000	11,110,000	139.00
8285	5	0.1	11,111	94.00
829	5	1	111,110	101.00
830	5	10	1,111,100	113.00
831	5	100	11,111,000	155.00
817-C	6	0.01	11,111.1	105.00
8315	6	0.1	111,111	109.00
832	6	1	1,111,110	121.00
833	6	10	11,111,100	169.00

UNMOUNTED DECADE RESISTANCES

Type	Dials	Ohm Steps	Total Resistance—Ohms	Price
435	1	0.1	1	$12.00
436	1	1	10	13.25
437	1	10	100	13.25
438	1	100	1,000	15.00
439	1	1,000	10,000	16.00
440	1	10,000	100,000	18.50
441	1	100,000	1,000,000	32.50
442	1	1,000,000	10,000,000	60.00



DECADE VOLTAGE DIVIDERS (Potentiometers)

Type	Dials	Ohm Steps	Total Resistance—Ohms	Price
845	3	1	1,000	98.00
837	4	0.1	1,000	126.00
835	4	1	10,000	132.00
836	4	10	100,000	146.00

SHALLCROSS MANUFACTURING COMPANY
510 Pusey Ave., Collingdale, Pa.

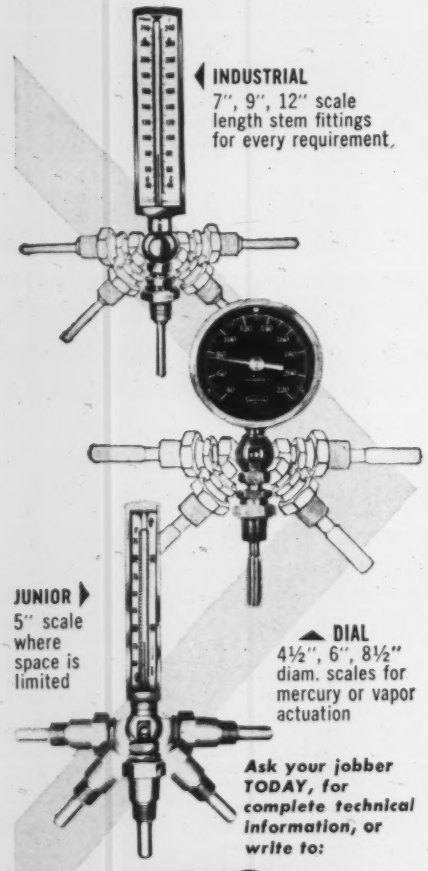
Shallcross

SEE US AT THE WESCON SHOW—BOOTH 1220
For more information circle **98** on inquiry card.

ADJUST-ANGLE THERMOMETERS

for any application ...for any industry!

Weksler ADJUST-ANGLE thermometers position to any angle through 180° arc, either before or after installation, by a simple locknut adjustment. Solves intricate installation problems with greater visibility at odd angles. Tested to withstand shock, vibration and strain, even under the most rugged conditions. Reduces installation and maintenance worries.



INDUSTRIAL 7", 9", 12" scale length stem fittings for every requirement.

JUNIOR 5" scale where space is limited

DIAL 4½", 6", 8½" diam. scales for mercury or vapor actuation

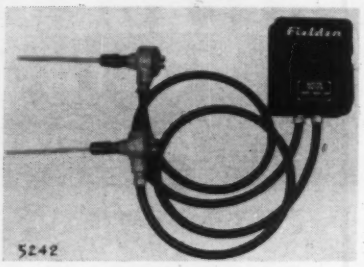
Ask your jobber TODAY, for complete technical information, or write to:

WEKSLER INSTRUMENTS

WEKSLER THERMOMETER CORP.
Dept. AA • 195 East Merrick Road
Freeport, L. I., N. Y.

For more information circle **99** on inquiry card.

NEW INSTRUMENTS



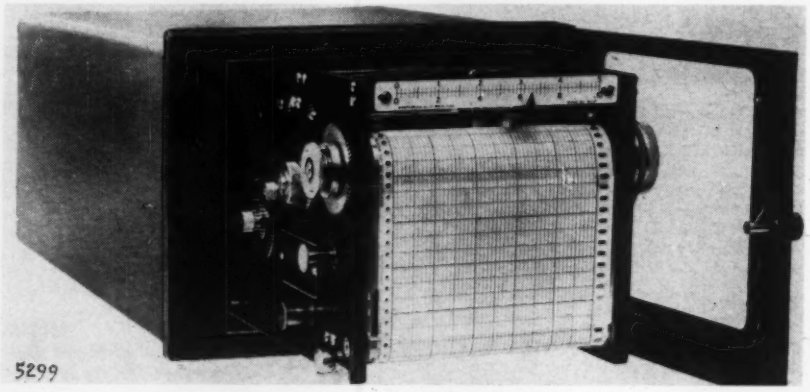
tor"; "differential Tektor"; and "time delay Tektor." Tube-in-probe model features additional circuitry, housed in an explosion-proof condulet and integrally mounted with sensing probe, whence control within closer tolerances than standard models. Differential model is for applications where the span between high and low levels is about 5 ft; has either single vertically-mounted probe, permitting differential to be changed at any time, or two shorter probes marking extremes of the span (illustrated). Time delay model controls flow of material delivered in clumps, waves or generally erratic so that probe often becomes bare of material. Adjustable time delay device allows succeeding wave of material sufficient time to reach probe, prevents convulsive start-and-stop performance of pumps, valves, etc.—*Fielden Instrument Div., Robertshaw-Fulton, 2920 N. Fourth Street, Philadelphia 33, Pa.*

For more information circle **308** on inquiry card.

Miniature Recorder

New strip-chart recorder is of null-balance potentiometer type; records on 5-in. translucent paper with pen speed of 0.5 sec full-scale and accuracy of 0.25%; is available with input sensitivities of 10 to 500 mv dc. No standard cell or batteries: standardization is continuous and automatic. Chart speeds are adjustable for 4, 10, or 20 iph; optional Selsyn drive with quick-change 3-speed transmission. —*Westronics, Inc., 3605 McCart Street, Ft. Worth, Texas.*

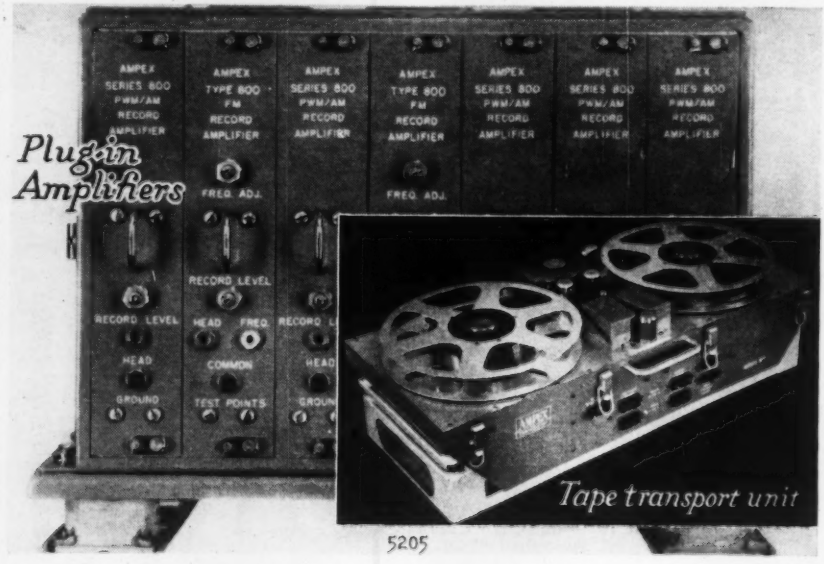
For more information circle **309** on inquiry card.



Magnetic-tape Recorders

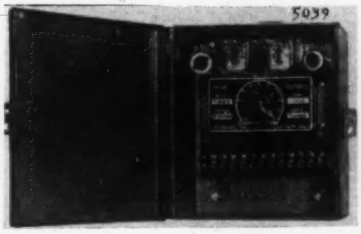
New "Series 800" light-weight shock-resistant recorders are available in models ranging from units designed to record two channels of information on ¼-in tape to those intended for recording 28 tracks on 2-in tape. Typical system comprises five cable-connected units: tape transport mechanism, record electronics, electronics power supply, tape transport power supply and remote control unit.—*Instrumentation Div., Ampex Corp., 934 Charter St., Redwood City, Calif.*

For more information circle **310** on inquiry card.



Process Timer

New "T-1" electronic timer with ± 2% repeat accuracy permits multiple modes of operation including in-



terval, delayed action, repeat cycle and single cycle timing; can be supplied with standard ranges of 0.3-25 or 0.5-50 sec. Dial assembly can be removed for remote operation. Cold cathode tubes eliminate warm-up time.—*Ferrara Inc., 8106 W. Nine Mile Road, Oak Park, Mich.*

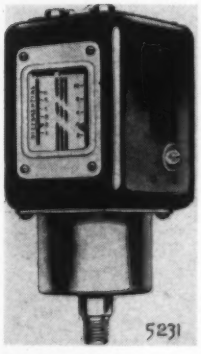
For more information circle **311** on inquiry card.

Electronic Manometer

New "Model 630" indicates the pressure of a contained gas in inches of mercury (range 3-7 in Hg), is used with maker's "VM-1" terminals installed in chamber. A constant current at high voltage is passed across these terminals. Manometer operates on 110 60-cps power; weighs less than 5 lbs. —*Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio*

For more information circle **312** on inquiry card.

Pressure Switches

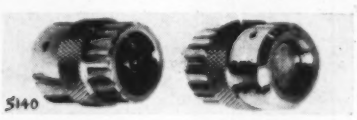


New "Fireye 80B Pressure Controls" provide high and low limit control for steam, air and non-corrosive liquids and gases from 3 in vacuum to 240 psig. On heating installations, new units can be used for high limit safety or to maintain steam pressure within set limits; on burners, they supply all required excess and minimum pressure safety interlocks. Calibrated dials indicate operating and differential pressure settings. Units mount in any position; standard connection ¼-in NPT.—*Electronics Corporation of America, 718 Beacon St., Boston 15, Mass.*

For more information circle **313** on inquiry card.

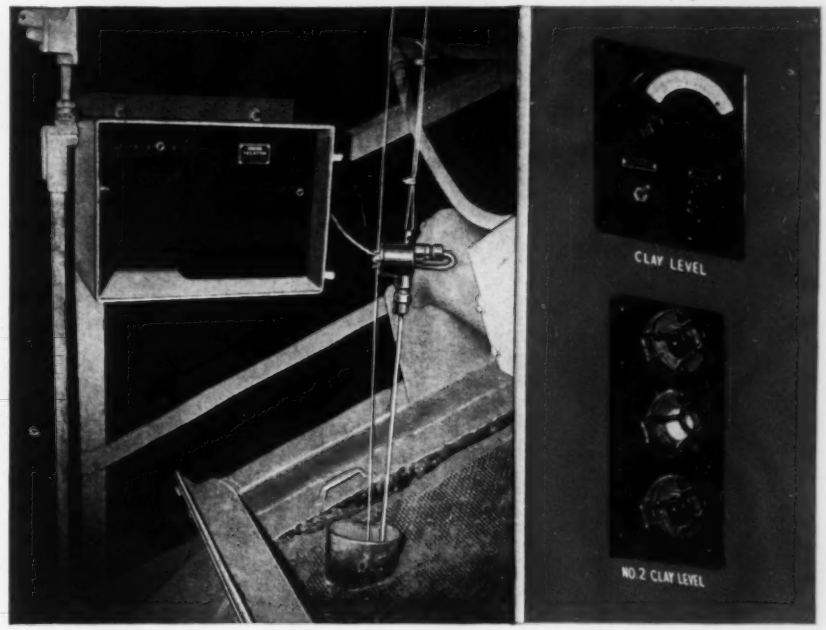
Pressure Pickup

New "Model P 450" can measure rapid pressure transients because of its 185-kc natural frequency (piezo-



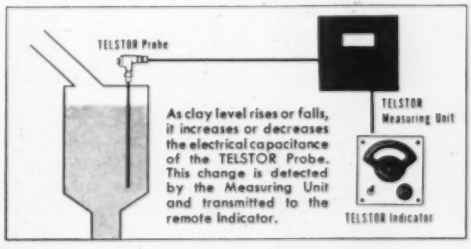
electric element) and its circular sensitive area of 9/16 in. diam. (At other end, a miniature coaxial connector.) Open circuit sensitivity 500 mv/psi;

At Magnolia Petroleum TELSTOR Saves Operator Time and Clay



A Fielden TELSTOR System now enables operators at Magnolia Petroleum Co., Beaumont, Texas, to keep tabs on spent clay as it flows from a lube oil filter to a storage hopper to a revivifying kiln.

Because of its ability to measure all types of material and catalysts, TELSTOR shows clay level in the hopper with good accuracy. Its simple and completely safe electronic system is unaffected by the clogging nature of the oil-saturated clay. Send the coupon today for more facts about TELSTOR.


TELSTOR Probe
As clay level rises or falls, it increases or decreases the electrical capacitance of the TELSTOR Probe. This change is detected by the Measuring Unit and transmitted to the remote indicator.
TELSTOR Measuring Unit
TELSTOR Indicator

TELSTOR Features

- For liquids, liquid interface, powders, granular solids (conducting or non-conducting).
- Measures spans up to 200 feet or any portion.
- Maximum pressure 1000 psi (350° F.); maximum temperature 750° F. (150 psi).
- No moving parts—only one radio tube.

Robertshaw-Fulton
CONTROLS COMPANY

FIELDEN INSTRUMENT DIVISION
Dept. A, 2920 N. 4th St., Philadelphia 33, Pa.

Please send me bulletins describing:

- ☐ TELSTOR Continuous Level Indicator
- ☐ TEKTOR Level Limit Control
- ☐ FIELDEN MULTI-POINT Recorders
- ☐ TEKTOLOG Recorders
- ☐ FIELDEN NULL-BALANCE Recorders

NAME _____ TITLE _____

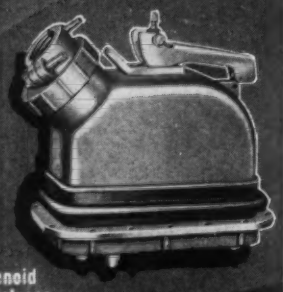
COMPANY _____

STREET _____

CITY _____ ZONE _____ STATE _____

For more information circle **100** on inquiry card.

40th YEAR
Cannon quality
in missile
launching connectors
means safety

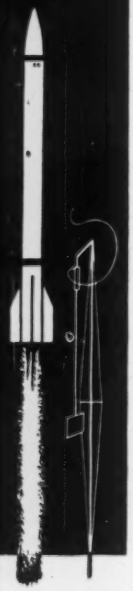


GMA–Solenoid or Manual Release. 41 to 140 Contacts. Coaxials Available.

GMJ–Skid Away Release. 18 Size 14 Contacts.

GMD–Skid Away Release. 22 or 50 Size 14 Contacts.

Performance of missile launching connectors cannot be "hit or miss." It must be right! That's where Cannon's reputation for quality and design experience can help you with the most complete and most reliable line available.



Write TODAY for GMI Bulletin.

CANNON PLUGS

CANNON ELECTRIC CO
3209 Humboldt Street
Los Angeles 31, Calif.

Please Refer to Dept. 180

For more information circle **101** on inquiry card.

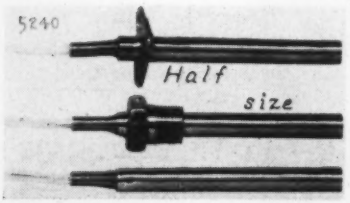
NEW INSTRUMENTS

pressure range 0.001 to 500 psi; frequency range 25 to 20,000 cps; temperature range –40 C to 90 C.—*Gulton Mfg. Corp., Metuchen, N. J.*

For more information circle **314** on inquiry card.

Midget Thermostats

New ¼-in-diameter "Thermoswitches," less than 2½ in long and weighing about 1 oz can be set to actuate at any specified temperature between –50 and 500 F. Contacts open when temperature exceeds set point; inverse action models are also available in which contacts close above set



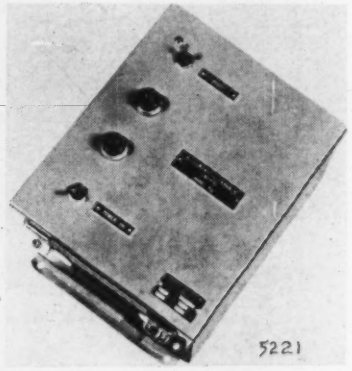
point. To meet various mounting requirements: a basic cartridge-style unit; two screw-in models with hex heads; and a flange head unit for surface mounting. Electrical load rating 1 amp @ 115 vac.—*Fenwal Inc., Ashland, Mass.*

For more information circle **315** on inquiry card.

MACHINE AUTOMATION

Press-clearance Control

New "Press Clearance Control" prevents press damage due to failure of parts ejectors (such failure causing

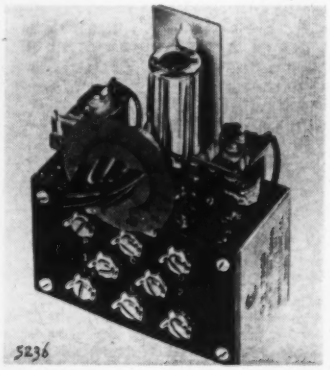


a press stroke on double stock thickness with resultant damage to press and dies). It is an automatic shut-off which works from an impact acceleration pickup on receiving tote box or unloading mechanism. Two models: "PCE" for presses with electrical clutch systems; "PCM" for presses with mechanical or pneumatic clutch actuator.—*Control Devices, Inc., 8299 E. Nine Mile Road, Van Dyke, Mich.*

For more information circle **316** on inquiry card.

Machine Cycle-repeat Timer

New "Model S44" produces a repetitive series of circuit closures; is a cold-cathode-tube electronic timer of

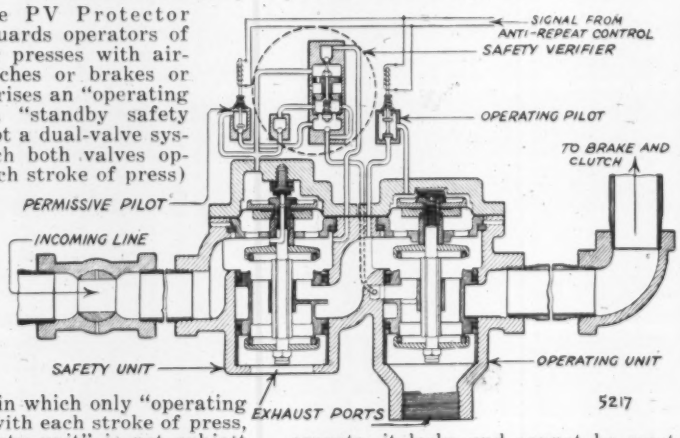


maker's "CK" type. Load circuit remains closed for a fixed time of about 60 milliseconds; and time between circuit closures can be adjusted between 0.03 sec and 24 sec. Duration load-circuit stays closed can be increased by connecting capacitance to terminals provided; or hold-in time can be shortened by connecting resistance.—*Farmer Electric Co., 21 Mossfield Road, Waban, Mass.*

For more information circle **317** on inquiry card.

Pneumatic Safety System for Presses

New "Type PV Protector Valve" safeguards operators of metalworking presses with air-operated clutches or brakes or both. It comprises an "operating unit" and a "standby safety unit." It is not a dual-valve system (in which both valves operate with each stroke of press)



but a system in which only "operating unit" moves with each stroke of press, whereas "safety unit" is not subject to regular-operation wear, so that possibility of simultaneous failure is virtually nil. When "safety unit" does operate, it locks and cannot be reset until fault is corrected.—*Clark Controller Co., 1146 E. 152nd St., Cleveland, Ohio.*

For more information circle **318** on inquiry card.

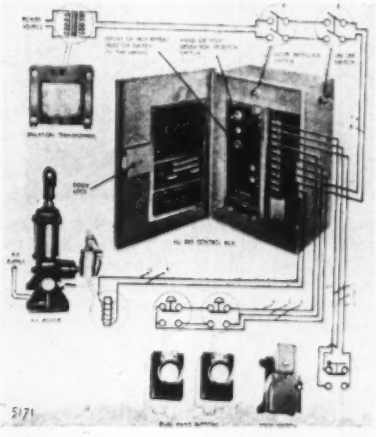
Automatic Gager-sorter

New "Type 80 Automatic Gear Gage" inspects hobbed gears dimensionally, sorts them into (1) acceptable, (2) salvageable and (3) unsalvageable and passes them into three corresponding chutes, at rates up to 1000 per hour; automatically controls hobbing machine for both pitch diameter and hob shift.—*Airborne Instruments Laboratory, Inc.*, 160 *Old Country Rd., Mineola, N. Y.*

For more information circle **319** on inquiry card.

Machine Cycle Controller

New "SCI 200 Electrical Control System" for predetermined repeat or non-repeat machine cycle comprises a control box plus either dual hand buttons or a single foot switch for each operator. Electric energy from plant line is stored in control box until both hand buttons are depressed, or until foot switch is depressed, disconnecting plant voltage and simultaneously releasing stored electric energy to operate air motor through a solenoid valve. With supply of stored electric energy exhausted, hand buttons or foot switch must be released to permit next machine cycle. System will control different types of machines.—*Dep't IA, Security Controls, Inc.*, 255 *Franklin St., Buffalo 2, N. Y.*



For more information circle **320** on inquiry card.

Machine Timer

New "Type 12 MC" is a low-cost electronic interval timer, suitable for push button, foot switch or other actu-

ACCURACY *at a glance!*

Just select the range you want... Hycon's new Model 615 *Digital* VTVM does the rest... gives you a *direct* reading in numerical form, complete with decimal point and polarity sign. There's no interpolation, no chance of reading the wrong scale. Even inexperienced personnel find the Model 615 easy to use... you *just can't* read it incorrectly!

Ideal for both laboratory and production-line testing, here's what the Model 615 offers...

...1% accuracy on DC and ohms; 2% on AC
...12 ranges... 0 to 1000 volts DC and AC; 0 to 10 megohms
...Illuminated 3-digit scale, with decimal point and polarity sign
...Response (with auxiliary probes) to 250 mc
...Shielded case; rugged, bench-stacking design; lightweight

Two more Hycon test instruments... designed for tomorrow's circuitry... *ready for color TV...*

MODEL 617 3" OSCILLOSCOPE...
Accurate enough for research, rugged enough for servicing. Features high deflection sensitivity (.01 v/in rms); 4.5 mc vertical bandpass, flat ±1 db; internal 5% calibrating voltage. **SPECIAL FLAT 3" CRT FOR UNDISTORTED TRACE FROM EDGE TO EDGE.**

MODEL 614 VTVM...
Maximum convenience combined with unprecedented low cost. Plus features include: 21 ranges (28 with p-p scales); 6½" meter; 3% accuracy on DC and ohms, 5% on AC; response (with auxiliary probe) to 250 mc. **TEST PROBES STOW IN CASE, READY TO USE.**

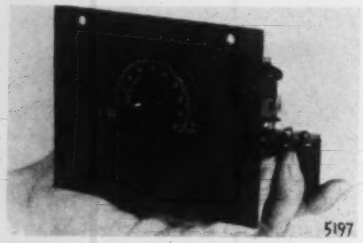
Don't Forget
See the complete line at the 1955 Wescon show
Booths 1812 and 1813

Hycon Mfg. Company
2961 EAST COLORADO STREET
PASADENA 8, CALIFORNIA

"Where accuracy counts"

BASIC ELECTRONIC RESEARCH • ORDNANCE • AERIAL CAMERAS • ELECTRONIC SYSTEMS
ELECTRONIC TEST INSTRUMENTS • GO NO-GO MISSILE TEST SYSTEMS • AERIAL SURVEYS

For more information circle **102** on inquiry card.



ation of spot welders, heat sealers, punch presses, washing or molding machines, etc. Use of filamentless cold-cathode eliminates warm-up time for intervals from 0.05 to 7 seconds (duration continuously adjustable). Simple spdt electromagnetic relay has normally-open 10-amp contacts.—*G. C. Wilson & Co., 1950 Eighth Ave., Huntington, W. Va.*

For more information circle **321** on inquiry card.

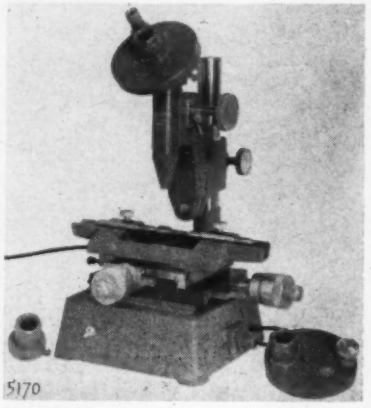
Timing Pushbutton

New combination push button and timer obviates need of purchasing separate push button station and timer, eliminates connecting wiring. Among applications: cascade arrangements where one unit starts cycle and modified additional units time out successive intervals, each energizing circuits in turn. Units are available in time ranges from 10 seconds to 80 hours, are easily and quickly set. Dial resets automatically after each cycle and repeats within a half percent of over-all range.—*Seeley Instrument Co., Inc., Niagara Falls, N. Y.*

For more information circle **322** on inquiry card.

Toolmaker's Microscope

New "Toolmakers Microscope" is said to be "completely universal, yet most economically priced as compared with similar instruments." It permits



precision measuring of coordinates to 0.0001 in., angles to 1 minute of arc, also radii, concentric circles, screw threads, etc. Stand is made in New York, optics by E. Leitz, Inc. (Western Zone Germany).—*George Scherr Optical Tools, Inc., 200 Lafayette St., New York 12, N. Y.*

For more information circle **325** on inquiry card.

DIMENSIONAL GAGING and INSPECTION

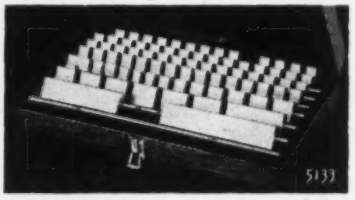
Optical Measuring Machine

New "Optical Measuring Comparator 350/60/360°," made by Askania-Werke A. G., is designed for measuring lengths (to 0.001 mm) and angles (to 1 sec) of recordings on photographic square plates up to 10 x 10 in. Measuring range: 14 in. in x-direction and approx. 2½ in. in y-direction. Rotating plate carrier allows measuring in any direction.—*Epic Inc., 154 Nassau Street, N. Y. 38, N. Y.*

For more information circle **323** on inquiry card.

Gage Blocks and Accessories

New "F-81" gage block set consists of 81 steel blocks producing about 240,000 different gages in 0.0001-in

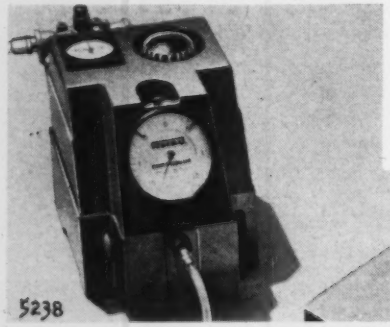


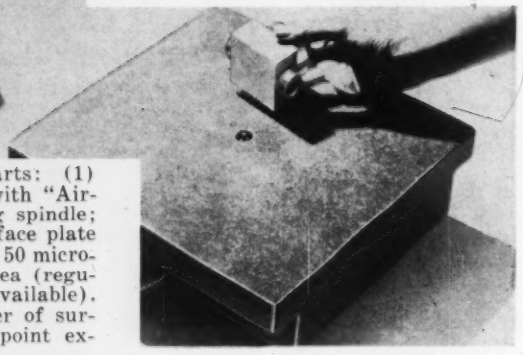
steps, minimum 0.200 in and a maximum beyond 12 in. Available in chrome plate and steel; protective end blocks available in tungsten-carbide.—*Freeland Gauge Co., 9940 Freeland Ave., Detroit 27, Mich.*

For more information circle **326** on inquiry card.

Flatness Gage

New "Model A-582 B-4 Air Flatness Gage" provides a rapid and extremely accurate method of checking surface





flatness. Two essential parts: (1) "Dimensionair Air Gage" with "Airprobe" universal air gaging spindle; (2) Rahn black granite surface plate with guaranteed accuracy of 50 microinches for any 2 ft x 2 ft area (regular size 12 x 12 in; others available). "AirProbe" is set into center of surface plate so that contact point extends slightly above surface. When a part is placed on surface plate and moved across contact point, any variation in flatness of part will depress spindle a different amount and this difference can be read on "Dimensionair" dial in increments of 50 or 20 microinches, depending on model.—*Federal Products Corp., 1144 Eddy St., Providence 1, R. I.*

For more information circle **324** on inquiry card.

Beta-ray Gage

New "Beta Gauge" measures thickness, or weight per unit area, of a continuous running strip of material; comprises three units: a detector head and radiation source, a control

unit, and an amplifier cabinet with recorder; actuates a visible or audible warning if pre-determined limits are exceeded; can be connected with processing mechanism to provide continuous automatic adjustment.—*Curtiss-Wright Corp., Wood-Ridge, N. J.*

For more information circle **327** on inquiry card.

Take a number—any atomic number from ~~7~~ 16 to 100

New G-E accessory extends practical range of x-ray spectrography down through SULPHUR

NOW you can get a direct chart record of all elements down to atomic number 16 with G-E x-ray diffraction units. General Electric has developed a helium tunnel assembly for use with the No. 2 SPG Spectrometer that increases sensitivity . . . permits for the first time routine accurate quantitative analysis of such widely present elements as sulphur, chlorine, potassium and calcium.

Substituting helium atmosphere for air in the path of soft x-rays greatly extends x-ray's fluorescence detection range. For example, the intensity of potassium goes up by a factor of 400. The intensity of radiation is such that low concentrations are measurable at levels which depend on the nature of the matrix — e.g., about .01 percent sulphur in oil. In many instances smaller atomic numbers than sulphur may be analyzed.

Of particular importance to such fields as petroleum, rubber and metallurgy — the new accessory can be adapted to existing No. 2 SPG Spectrometers with a simple conversion kit. For complete information, see your G-E x-ray representative, or write X-Ray Department, General Electric Company, Milwaukee 1, Wisconsin. Request Pub. BL-84.

Progress Is Our Most Important Product

GENERAL ELECTRIC

For more information circle **103** on inquiry card.

Miniature Pressure Transducers

STATHAM UNBONDED STRAIN GAGE TRANSDUCTION

MINIMUM RESPONSE TO VIBRATION OR ACCELERATION

TEMPERATURE COMPENSATION OVER 315° F. INTERVAL

20 MILLIVOLTS AT 5 VOLT EXCITATION

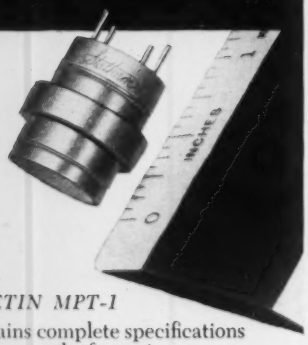
PRESSURE ADAPTERS FOR CLOSED LINE APPLICATIONS

HOMOGENEOUS SENSING DIAPHRAGM SURFACE

NO EPOXY RESIN PRESSURE SEALS

MAXIMUM LINEARITY

ABSOLUTE PRESSURE
0-5 to 0-150 PSIA . . . MODEL P130
DIFFERENTIAL PRESSURE
±2.5 to ±25 and 0-5 to 0-150 PSID . . . MODEL P131
GAGE PRESSURE
0-5 to 0-150 PSIG . . . MODEL P132



BULLETIN MPT-1
contains complete specifications on the foregoing pressure transducer models.

All matters pertaining to sale or use of instruments of our manufacture are handled by engineering personnel directly from our Los Angeles plant.

Please feel free to wire or telephone us collect whenever we may be of service.

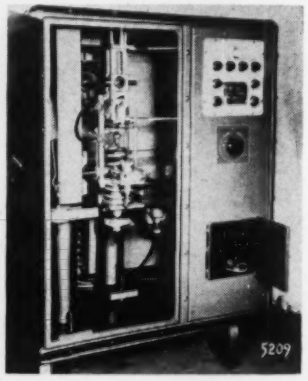
Statham
LABORATORIES
12401 W. Olympic Blvd., Los Angeles 64, Calif.

For more information circle **104** on inquiry card.

MECHANICAL TESTS, FORCE, LOAD, etc.

Constant Preloading for Fatigue Tester

New automatically maintained constant preload equipment, available on "Sonntag SF-01-U" 400-lb universal

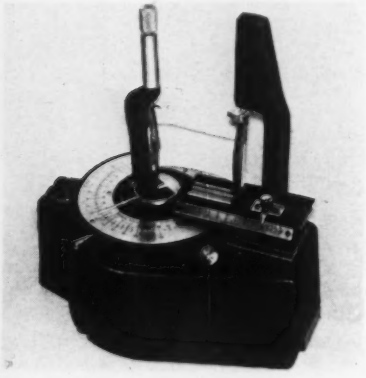


fatigue machine, corrects automatically for creep which may be produced in test specimens while they are being subjected to constant fatigue loads.—*Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.*

For more information circle **328** on inquiry card.

Stiffness Tester

New "Carson-Worthington Universal Stiffness Tester" measures stiffness and related properties of paper, cards, coated fabrics, metal foils, leathers, plastic sheets and films, etc., also effects of coatings, treatments and dimensional differences in stiffness and related properties. Features: easy interchange of torsion units to different sample sizes and stiffness values; data recorded in gram-centimeter rather than relative units; self-checking; excellent reproducibility.—*U. S. Testing Co., Inc., 1415 Park Ave., Hoboken, N. J.*



For more information circle **329** on inquiry card.

Leak Detector

New "Type M-1" of GE mass spectrometer leak detector is smaller, easier to maintain and four times

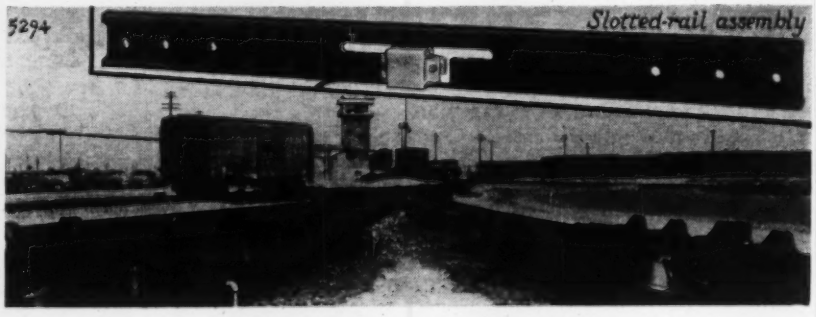
more sensitive than its predecessor: is designed to detect a leak rate of 5 x 10^{-10} cc of air per second entering an evacuated system under atmospheric pressure. It can be used selectively to locate a specific leak in the presence of other leaks, without loss of sensitivity. Twenty sensitivity ranges are provided. All components can be easily disassembled for cleaning and replacement. Perfect realignment of mass spectrometer tube is assured after cleaning and replacement of parts, since all components are aligned on a single removable flange. To replace a filament requires less than 15 min.—*Instrument Dep't, General Electric Co., West Lynn 3, Mass.*

For more information circle **330** on inquiry card.

Railroad Car Rapid Weighing System

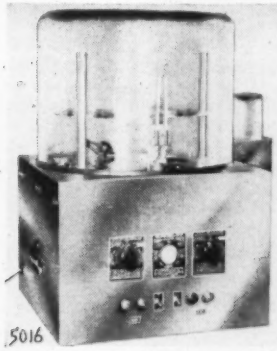
New "Car Weighing Device" provides full-automatic control of master and intermediate retarders in classification yards. It weighs each axle of a cut and weight results in energization of corresponding relays in a coordinating unit. This unit is arranged to average the weight of a cut so that retarder operation is governed by average cut weight rather than individual axle weight. A variety of averaging methods can be provided.—*Union Switch & Signal Div., Westinghouse Air Brake Co., Pittsburgh 18, Penna.*

For more information circle **331** on inquiry card.



Temperature and Humidity Test Chamber

New "Vapor-Temp," low-cost mechanical convection controlled-temperature and controlled-relative-humidity

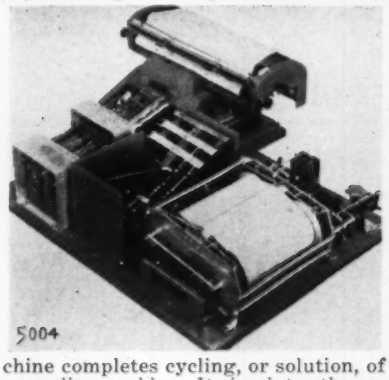


cabinet, features 100% accessibility, 100% visibility, 8-point hermetically sealed lead-in terminals and adjustable air flow; controls relative humidity from 20% to near saturated, without condensation on test specimen.—*Blue M Electric Co., 138th & Chatham St., Blue Island, Ill.*

For more information circle **332** on inquiry card.

Accounting-machine Tester

New automatic tester for assembly-line testing of accounting machines delays feeding of next problem until ma-

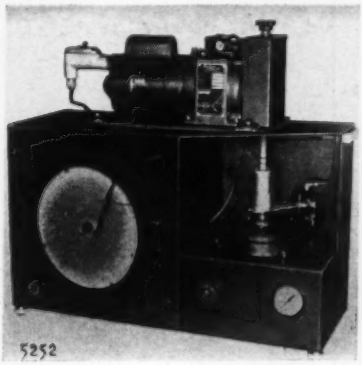


chine completes cycling, or solution, of preceding problem. It simulates the actual hand-key operations that an experienced operator would perform, but without possibility of human error.—*American Automatic Typewriter Co., 2323 N. Pulaski Rd., Chicago 39, Ill.*

For more information circle **333** on inquiry card.

Viscosimeter

New "High Shear Viscometer" is for testing flow properties of pigment suspension in manufacture of paper,



DEPEND ON

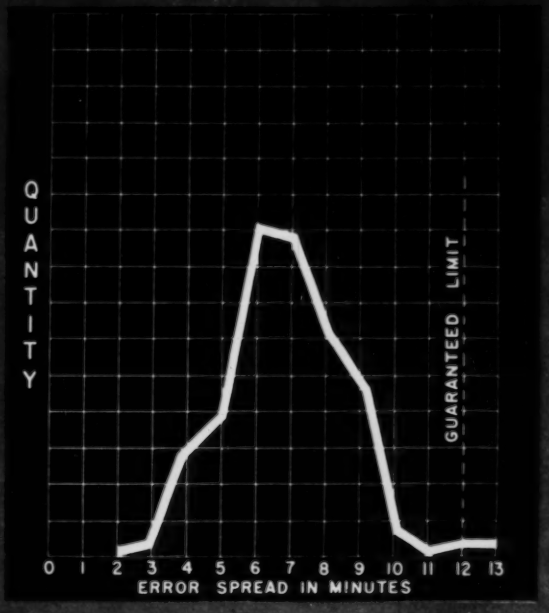
CLIFTON SIZE 10 SYNCHROS

for Consistant

HIGH ACCURACY

Error Spread Curve for a typical month's production of transmitters.

- Average Error Spread 7'
- Average Max. Error from EZ about 5'
- Average RMS Error under 3'
- GUARANTEED Maximum Error Spread 12'



See Us At WESCON!
Booth No. 1620
San Francisco
Aug. 24, 25, 26

IMMEDIATELY AVAILABLE

For full engineering information on transmitters, receivers, resolvers, differentials and control transformers, and complete lines of Size 11 and 15 synchros also immediately available, write or telephone T. W. Shoop, Sales Mgr. (Telephone Phila.) MAdison 6-2101.

West Coast Rep. Wm. J. Enright, 988 W. Kensington Rd., Los Angeles. MUtual 6573.

LOOK TO CPPC FOR cppc *SYNCHRO PROGRESS*

CLIFTON PRECISION PRODUCTS CO. INC.
CLIFTON HEIGHTS PENNSYLVANIA

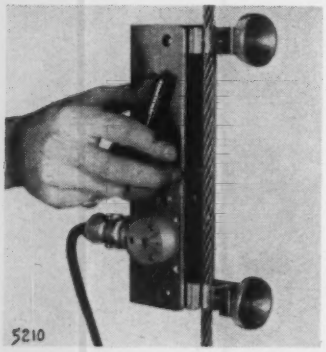
For more information circle **105** on inquiry card.

paints, printing inks and, in some cases, plastics and food. It represents a new approach to design of rotational viscometers capable of producing high rates of shear, in that it uses a pneumatic balance system instead of springs in measuring and recording shearing force in terms of torque. Balancing force is established by a pneumatic pressure, whose value is an accurate measure of torque developed by viscous drag. Output air pressure, or viscous drag, is recorded by "Hagan Ring Balance Gauge," which simultaneously records rate of shear.—*Hagan Corp., 323 Fourth Ave., Pittsburgh 30, Penna.*

For more information circle **334** on inquiry card.

Tension Gage

New "SR-4 Tensiometer," attached on a taut cable by end clamps, measures tension by force exerted on an adjustable pin that deflects cable midway between clamps; this force being measured by resistance wire strain

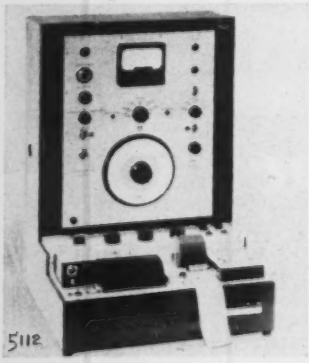


gages, whose output is transmitted to a central indicator or recorder. Available for loads up to 5000 lb on cables up to ½-in diam but can be made for other sizes and types of cables.—*Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.*

For more information circle **335** on inquiry card.

Sound and Vibration Analyzer

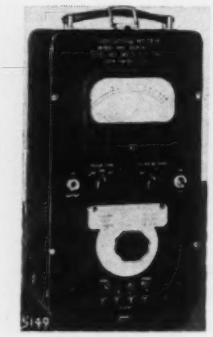
New "Model B L-2109 Third Octave Spectrum Analyzer" utilizes narrow frequency band analysis to provide physical measurement data easily correlated with subjective tests for loudness of sound or intensity of vibration; works in 35-18,000 cps range; uses 27 fixed ⅓-octave band filters with associated low-noise high-gain



amplifiers; affords manual or automatic switching, with data read from an indicator or autographed through a connection to maker's "Model BL-2304 Level Recorder."—*Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio.*

For more information circle **336** on inquiry card.

Vibration Meter

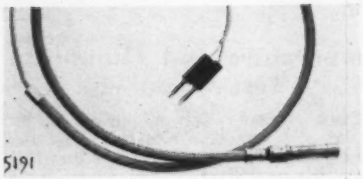


New "Model M6" measures voltage generated by velocity-type pickups attached to objects or surfaces being tested, yields quantitative data on amplitude, velocity and acceleration; has input connections for four pickups, and selector switch, also jack for connecting to recorder or oscilloscope.—*MB Mfg. Co., Inc., New Haven, Conn.*

For more information circle **337** on inquiry card.

Ultrasonic Probes

Two new "Glennite" ultrasonic probes, for measurement of both high- and low-intensity ultrasonic power in various kinds of liquids, are announced: "LU 100" with response from 100 kc to 2 Mc; and "LU 101"

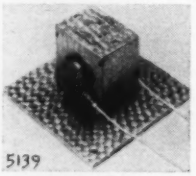


100 kc to 3 Mc. In 100-800-kc range, new probes are accurate measuring means for ultrasonic intensities; beyond 800 kc they can be used as detectors giving approximate values. "—Model LU 100" is encased in a solid plastic housing; "LU 101" in an all-metal and Teflon housing. Special units can be fabricated from stainless steel.—*Vibro-Ceramics Corp., Metuchen, N. J.*

For more information circle **338** on inquiry card.

Vibration Generator

New "Model AT-10A" piezoelectric high-frequency vibrator, for vibrational resonance testing of electron tubes, for calibrating accelerometers, etc., has a fundamental resonant frequency of 27 kc and is resonant-free up to that point; handles loading masses up to 3 oz. Sensitivity 2.3 microinches per 55 volts input; acceleration range up to ½ *G* at 1 kc and 50 *G* at 10 kc.—*Gulton Mfg. Corp., Metuchen, N. J.*

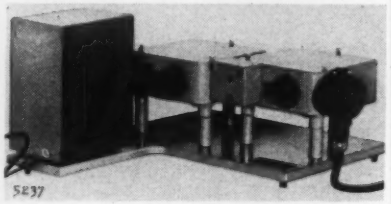


For more information circle **339** on inquiry card.

LABORATORY EQUIPMENT

Spectrofluorometer

New Spectrofluorometer determines spectral distribution of fluorescence and efficiency of excitation of fluor-

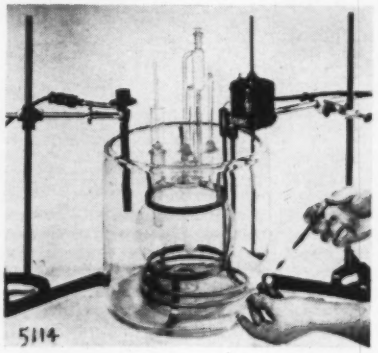


escence; is for selection of wavelength of excitation, analysis of spectra of fluorescent compounds, and fluorochemical methods of analysis. Important feature is that analyses can be made in ultraviolet, visible or infrared regions. Instrument can be provided with a recording or oscilloscope presentation.—*Farrand Optical Co., Inc., Bronx Blvd. & E. 238th St., New York 70, N. Y.*

For more information circle **340** on inquiry card.

Vapor-equivalent Apparatus

New Vapor Equivalent Apparatus (developed by Phillips Petroleum Co.) is for rapid (10-min.) determinations of vapor equivalent in residues from natural gas samples, or of any liquid with a vapor pressure of more than 4 mm at temperature of vaporization bulb; also determines molecular weights; is calibrated with pure hy-

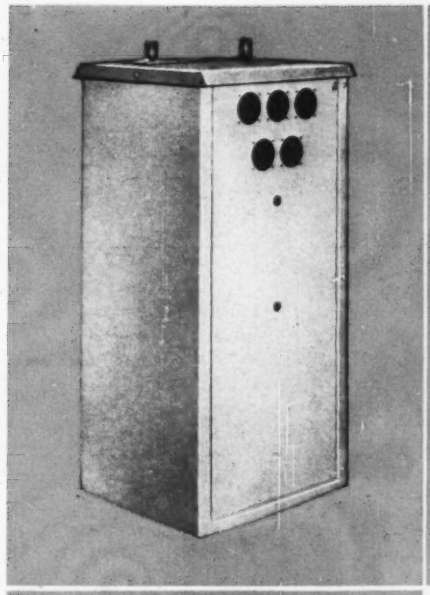


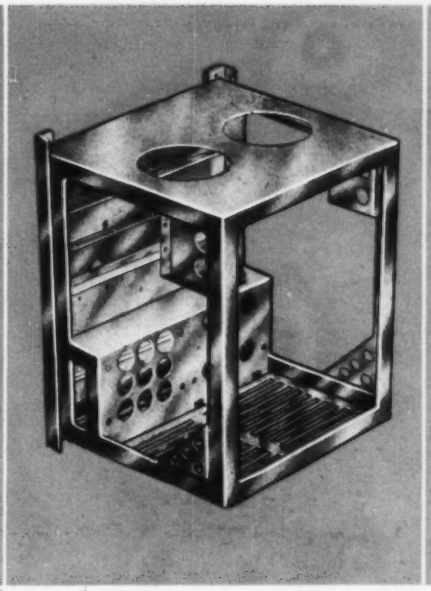
drocarbons having molecular weights between 72 and 150. Optional accessories include motor stirrer, thermoregulator, power transformer, clamps and support stands.—*Central Scientific Co., 1700 Irving Park Road, Chicago, Ill.*

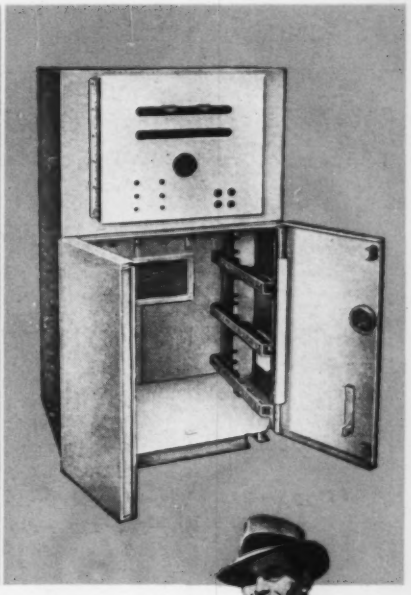
For more information circle **341** on inquiry card.

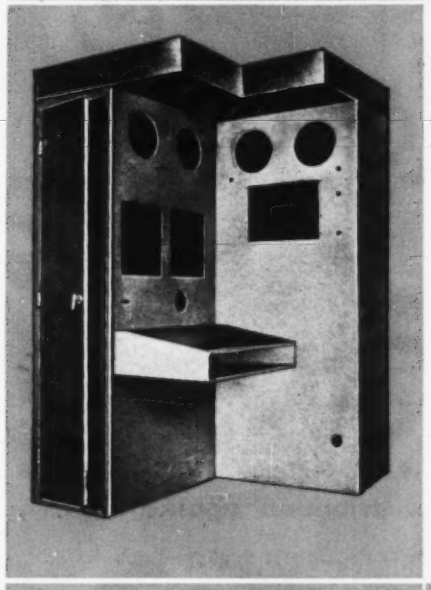
Sieve Shaker

New "Cenco-Meinzer Industrial Sieve Shaker," for mechanical analysis of industrial materials, or for sieving heavy mineral powders, light organic samples or fine pharmaceutical powders, holds up to six standard 8-in. sieves; can separate a mixture by particle size into six components in one operation. Owing to unique shaking motion, accurate separation is ob-









if it's

METAL FABRICATION

your

FALSTROM MAN

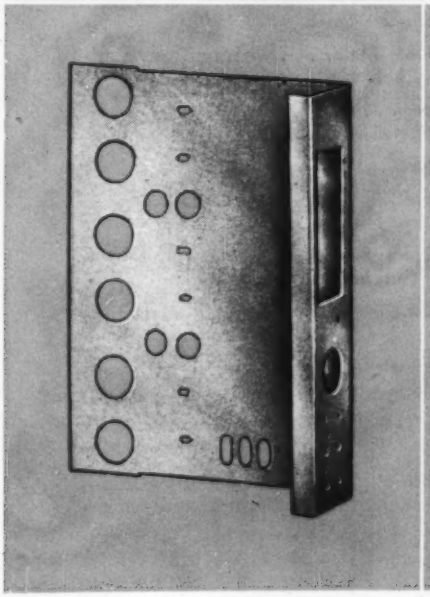
has the answer!

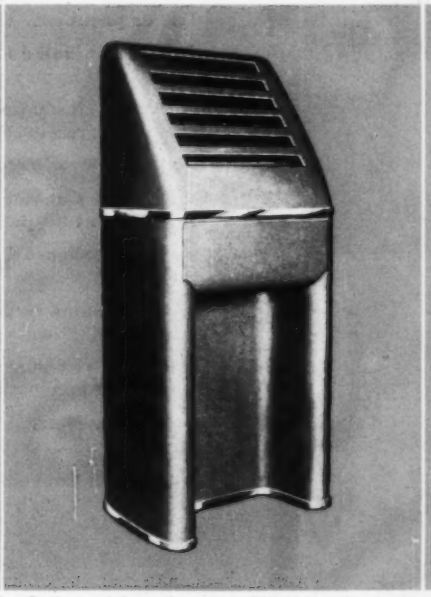
Since 1870 Falstrom engineers have been serving America's industry.

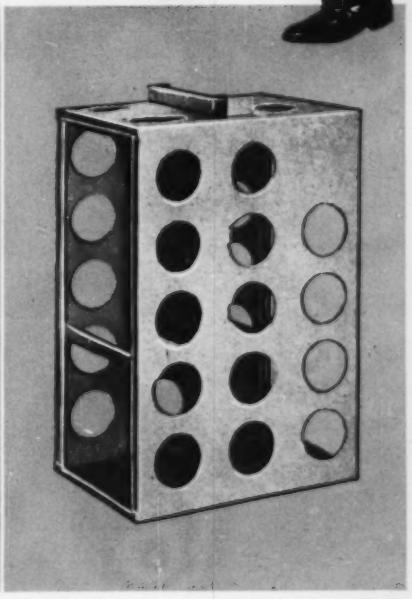
For fabrication of large or small shapes to close tolerances—in aluminum, sheet steel, stainless steel, copper, brass and other alloys—complete design-engineering—production service—modern facilities for punching, shearing, bending, welding, finishing . . . ask your Falstrom man—he'll have the answer.

Write for Bulletin 142 or send prints for quotation, without obligation.

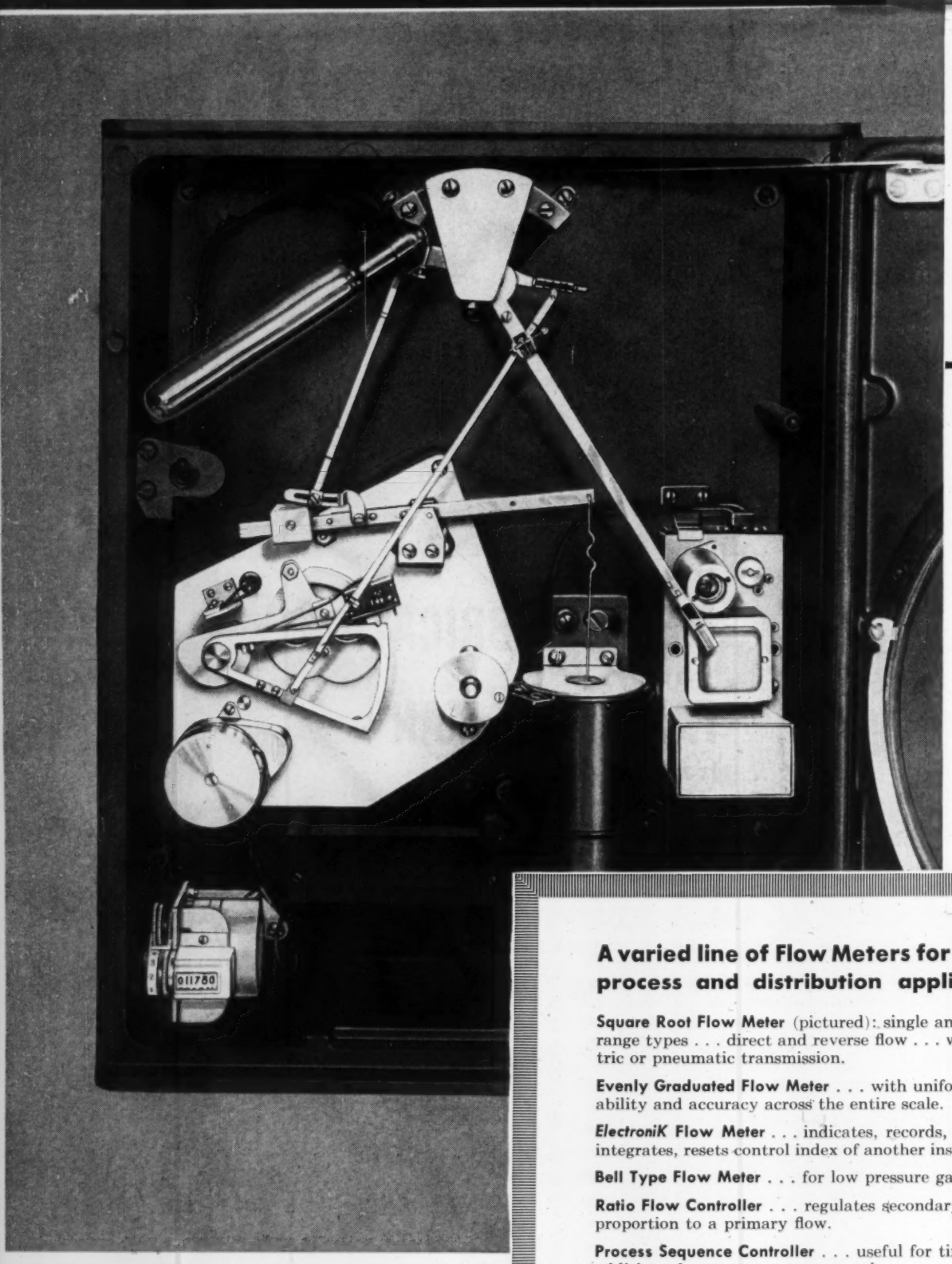
FALSTROM COMPANY 92 Falstrom Court, Passaic, N. J.
PRescott 7-0013 **Since 1870**







For more information circle **107** on inquiry card.



A varied line of Flow Meters for every process and distribution application

Square Root Flow Meter (pictured): single and double range types . . . direct and reverse flow . . . with electric or pneumatic transmission.

Evenly Graduated Flow Meter . . . with uniform readability and accuracy across the entire scale.

***ElectroniK* Flow Meter** . . . indicates, records, controls, integrates, resets control index of another instrument.

Bell Type Flow Meter . . . for low pressure gases.

Ratio Flow Controller . . . regulates secondary flow in proportion to a primary flow.

Process Sequence Controller . . . useful for timing the addition of reagent to a preset cycle.

Parshall Flume Meter . . . for measuring flow in open channels and weirs.

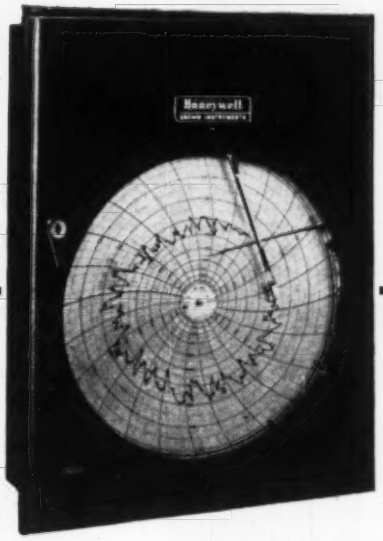
***Tel-O-Set* Miniature Instruments** . . . for graphic panels and other applications where space is at a premium.

Area Flow Meter . . . electric meter body for use with viscous fluids.

Differential Converter . . . the mercuryless flow transmitter with high sensitivity, precision and rangeability.

▲ *Reference Data:*

Write for Catalog 2321, "Flow Meters, Indicating, Recording, Integrating, Controlling."



The Brown Flow Meter line

was designed for your process applications

An important reason why Brown flow meters give you better performance is that they were designed specifically for flow recording, integration and control in industrial processes. Far from being step-children of boiler plant instruments, they embody features that fit the needs of modern production technology. Their design has been refined and perfected throughout 28 years of experience in flow instrumentation . . . to assure you of the utmost in precision, versatility and reliability.

For measurement, Brown Flow Meters give you a complete range of meter bodies to work with any fluid at any pressure . . . either electrical or pneumatic transmission . . . and the flexibility of interchangeable range tubes.

For integration, Brown Flow Meters feature accurate, simple electronic flow integration, in a design that places no mechanical load on the measuring mechanism.

For control, Brown Flow Meters, particularly those with square root calibration, offer an unequalled variety of control actions to match the needs of the simplest to the most complex process requirements.

For service, Brown Flow Meters give you basically simple and rugged designs that cut maintenance to the minimum . . . plus the convenience of prompt assistance in start-ups, routine maintenance and emergencies, by Honeywell specialists located near your plant.

Ask your local Honeywell sales engineer to discuss your flow applications. He's well qualified to give competent consultation . . . and he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

For more information circle **108** on inquiry card.

DAVIS

a complete line of

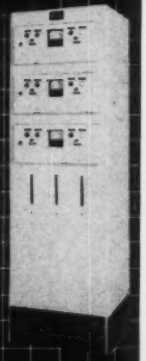
GAS ANALYSIS SYSTEMS

operating by catalytic combustion, electro-conductivity, thermal conductivity, and photochemical reactions.

Continuous ELECTRO-CONDUCTIVITY GAS ANALYZER

For the analysis of gases and vapors that ionize in water, directly or when decomposed by heat. Sensitive to small quantities.

Send for Bulletin 11-70



Continuous COMBUSTIBLE GAS ALARM SYSTEMS

For the protection of life, property and processes against combustible gases and vapors in air. Gives audible and visual alarm signals.

Send for Bulletin 11-36

PHOTOCHEMICAL OXYGEN ANALYZER

Continuous measurement of oxygen in gaseous streams, 0-100 p.p.m. Outstanding for simplicity of operation, specific measurement of oxygen without interference from most other gases.

Send for Bulletin 11-40

INSTRUMENT DAVIS DIVISION

DAVIS INSTRUMENTS

80 Halleck St., Newark 4, N. J.

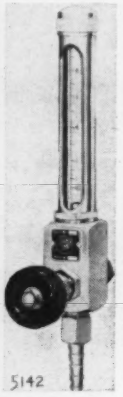
Progressive Manufacturers of Gas Analysis Instruments

For more information circle 109 on inquiry card.

NEW INSTRUMENTS

tained quickly and plugging or caking of sieves is eliminated. Operates on 115 v dc or ac.—*Central Scientific Co., 1700 Irving Park Road, Chicago, Ill.*

For more information circle **342** on inquiry card.



Oxygen-flow-rate Meter

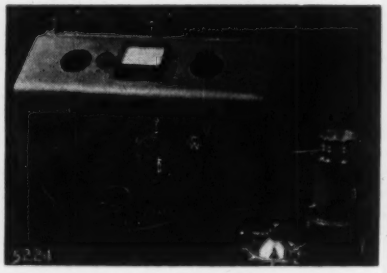
New "Model 1315" flowmeter for medical applications delivers regulated flow of oxygen from ½ to 9 liters/minute; is suitable for infant incubators; aids in preventing RLF. Needle valve facilitates precise adjustments. Large red graduations on unbreakable plastic housing, and ball float, enable at-a-glance readings of flow-rate.—*Hoke, Inc., 231 S. Dean St., Englewood, N. J.*

For more information circle **343** on inquiry card.

Lab Ultrasonics

Four new ultrasonic laboratory generators (console to table types) for research and small production in bacteriology, chemistry, nutrition and immunology, are available with a variety of accessories: glass cylinders for small-scale mixing, emulsification and depolymerization in solution; reflectors to concentrate a sonic beam; multi-chambered funnels for continuous irradiation of a flowing fluid, etc. —*Industrial and Scientific Products Div., Curtiss-Wright Corp., Caldwell, N. J.*

For more information circle **344** on inquiry card.



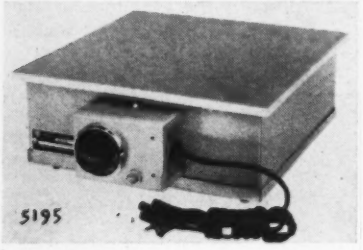
Automatic Demineralizer

New "MA-200 Mono-column Demineralizer," for users of 200 gph of high purity water, comes as a "package." Once it is installed, all operating functions are automatized. Whenever effluent's conductivity falls below standard, treated water is automatically discharged and lights (or other warning systems) signal need for activation of a regeneration cycle. Turn of switch then puts unit through its regeneration cycle automatically. —*Penfield Mfg. Co., Inc., 19 High School Ave., Meriden, Conn.*

For more information circle **345** on inquiry card.

Hot Plate

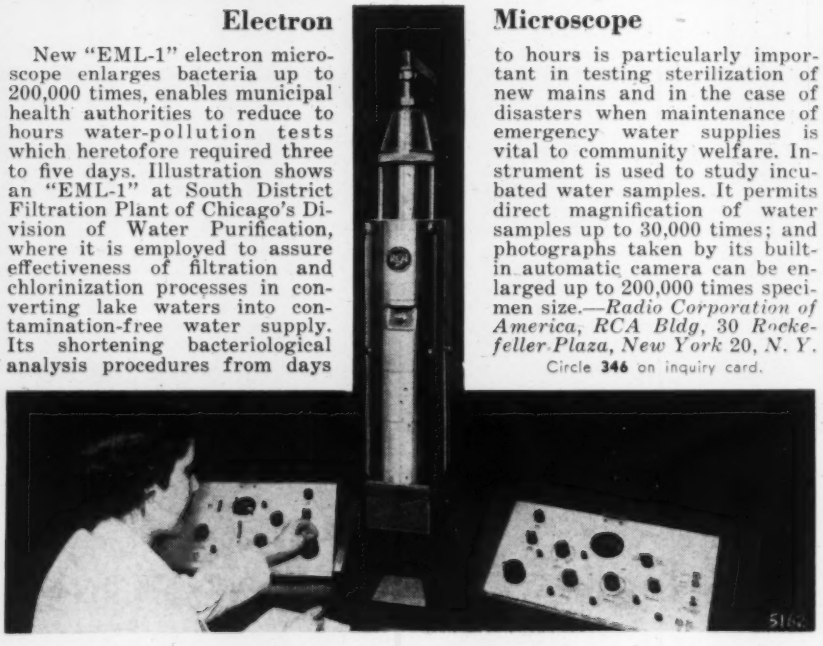
New "Model 1212" laboratory hot plate with 12 x 12 in heavy aluminum top for general industrial and laboratory use, operates on standard ac volt-



Electron Microscope

New "EML-1" electron microscope enlarges bacteria up to 200,000 times, enables municipal health authorities to reduce to hours water-pollution tests which heretofore required three to five days. Illustration shows an "EML-1" at South District Filtration Plant of Chicago's Division of Water Purification, where it is employed to assure effectiveness of filtration and chlorinization processes in converting lake waters into contamination-free water supply. Its shortening bacteriological analysis procedures from days to hours is particularly important in testing sterilization of new mains and in the case of disasters when maintenance of emergency water supplies is vital to community welfare. Instrument is used to study incubated water samples. It permits direct magnification of water samples up to 30,000 times; and photographs taken by its built-in automatic camera can be enlarged up to 200,000 times specimen size.—*Radio Corporation of America, RCA Bldg, 30 Rockefeller Plaza, New York 20, N. Y.*

Circle **346** on inquiry card.



ages; is rated at 1600 watts. Temperature is automatically controlled by thermostat adjustable between 100° to 500° F plate temperature. Pilot light indicates "on" and "off".—*Waage Electric, Inc., Colfax Ave., P. O. Box* 148-70 *Kenilworth, N. J.*

For more information circle **347** on inquiry card.

Gas Chromatography Apparatus

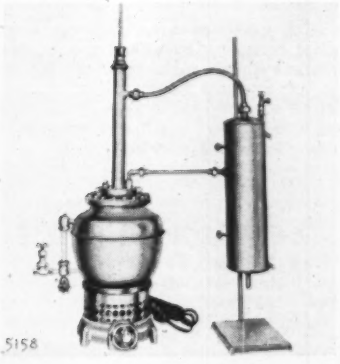
New "Kromo-Tog," unit-package instrument for gas chromatography, utilizes a simplified quantitative meth-

od of analysis based on differences in adsorption affinity of components in a mixture. Measured gas samples are washed through a column filled with an adsorbent: time required for each component to be washed is recorded and concentration in washing gas is measured. Two models, with one or two columns. Latter saves time. Illustration shows only upper part of floor-standing instrument.—*Burrell Corp., 2223 Fifth Ave., Pittsburgh* 19, *Penna.*

For more information circle **348** on inquiry card.

Solvent Recovery Still

New solvent recovery still is claimed to "actually pay for itself in a short time by the economical recovery of



solvents in laboratories where large amounts of such solvents are used for extraction." Feature: "RS Three-heat Hot Plate" for rapid heating until distillation begins and then reduced heat to maintain desired distillation rate.—*Precision Scientific Co., 3737 W. Cortland St., Chicago* 37, *Ill.*

For more information circle **349** on inquiry card.

Hypo Needle Cleaners

New "American Needle Cleaners" do a more thorough, dependable and faster job of cleaning hypodermic

BARTON **RUPTURE PROOF BELLOWS RECORDERS**

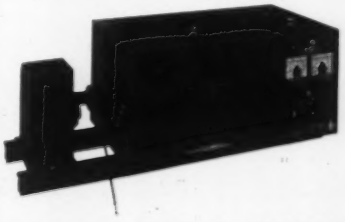
accurately draw a picture story of flow — liquid-level and/or differential pressure. Operating from 0-20″ W. C. min. to 0-400 psid max. at safe working pressures to 3000 psig, and in some cases to 6000 psig with little or no maintenance.

For further information request bulletin 11C-4 or contact BARTON sales engineers, located in most principal cities.

Model 199 Bellows Assembly "The Heart of all Bartons"

BARTON INSTRUMENT CORPORATION
INDUSTRIAL INSTRUMENTS
1429 SOUTH EASTERN AVENUE · LOS ANGELES 22, CALIFORNIA

For more information circle **110** on inquiry card.



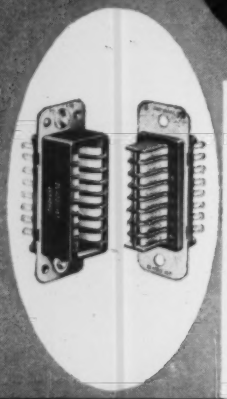
NEW 1000-Series
BRICE-PHOENIX
UNIVERSAL LIGHT-SCATTERING PHOTOMETER
Measures Absolute Turbidity, Dissymmetry and Depolarization of Dilute Solutions of High Molecular-Weight Compounds

Phoenix Precision Instrument Co.
3803-05 N. Fifth St., Philadelphia 40, Pa.

For more information circle **111** on inquiry card.

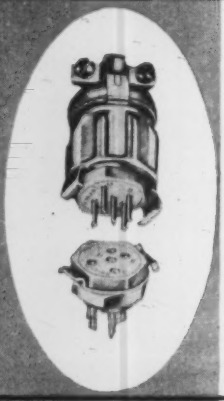
VERSATILE

26 SERIES RACK and PANEL CONNECTORS



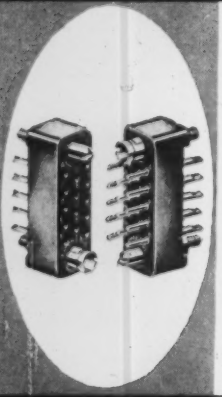
BLUE RIBBONS
8, 16, 24, 32 contacts

Thousands of these famous quick-disconnect connectors are being used for plug-in sub-assemblies, as in computers, where ease, speed and reliability are important. Available with pin & socket or barrier polarization; latter types are available with keyed shells and latch-lock cans.



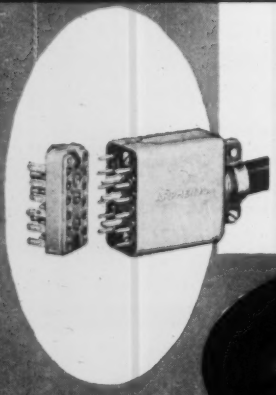
HEX MINIATURES
4, 5, 7, 9 contacts

Designed to cover a wide range of miniaturized applications by the use of interchangeable hardware and contacts. Hex nut type has threaded body for panel mounting without the use of external shells. Locking Clip type permits positive mating with Hood & Cable Clamp types.



RECTANGULAR MINIATURES
14, 15, 18, 21, 34 contacts

Extremely small pin and socket types, available in numerous contact arrangements. Guide pins and bushings for positive alignment.



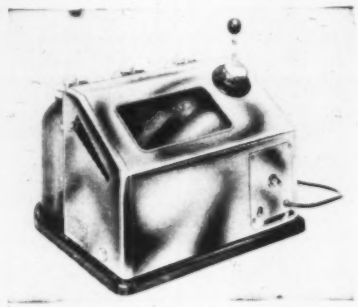
RECTANGULARS
11, 15, 20 contacts

Available with protective aluminum housings with top or side cable outlets. Connectors have eyelets inserted in the mounting holes for extra strength. Interlocking barriers prevent accidental shorting.

AMPHENOL

AMERICAN PHENOLIC CORPORATION
chicago 50, illinois
In Canada: AMPHENOL CANADA LTD., Toronto

NEW INSTRUMENTS



needles than do hand methods; provide electrically-driven shaft for power swabbing of needle hubs, and triple-sequence flushing by three cleaning fluids consecutively forced through each needle under 25 psi pressure, followed by forced air drying.—*American Sterilizer Co., Erie, Penna.*

For more information circle **350** on inquiry card.

Raman Spectrometer

New "Model R Photoelectric Recording Raman Spectrometer" features a Toronto-type helical mercury-arc excitation source and a coated op-

tical system for transferring Raman radiation from sample tube to monochromator; operates through 100-3500 cm^{-1} frequency range. Survey spectra can be scanned in 12 min., high-resolution spectra in 50 min.—*Perkin-Elmer Corp., Norwalk, Conn.*

For more information circle **351** on inquiry card.

Variable-speed Stirrer

New "Model #101," added to maker's T-line" of stirrers, is claimed to have "features no other stirrer has." Several used together can replace an

← Circle **112** on inquiry card.

expensive multiple stirring unit. It is strong enough to agitate thoroughly over 5 gallons of water. It has a stainless steel collet type chuck, continuous-duty Bodine motor, rheostat with an off position to 5000 rpm, calibrated dial for duplicating speeds.—*Talboys Instrument Corp., 13 Ackerman Ave., Emerson, N. J.*

For more information circle **352** on inquiry card.

NUCLEONICS

Scintillation-type Survey Meter

New "Model 389H Super Scintillac," using interchangeable phosphors to detect alpha, beta, or gamma radiation, has six sensitivity ranges in counts per minute, and four time constants. Built-in amplifier is provided for operation of a recorder.—*Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio*

For more information circle **353** on inquiry card.

Portable Scintillation Counter

New "Model 645 Scintillac" has six sensitivity ranges calibrated in counts per minute, and four time constants. A number of probes for alpha, beta or gamma radiation detection can be used interchangeably. Gamma probes for hand use, or lead shielded and shock mounted for aerial or automobile surveys, and with crystal sizes up to 2 x 2 in can be used. Total weight is under 8 lbs.—*Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.*

For more information circle **354** on inquiry card.

Prospector's Counter

New "Geiger Counter #803" is said to be "able to detect ore with as little as 0.01% uranium (0.05 milliroentgen per hour)." It uses a low-drain battery-operated circuit, and indicates simultaneously by flashing neon lamp and headphone clicks.—*Electronic Instrument Co., Inc., 84 Withers St., Brooklyn 11, N. Y.*

For more information circle **355** on inquiry card.

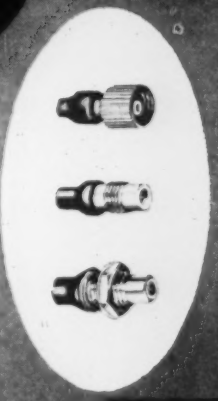
Geiger Counters

Six new Geiger counters meet different sensitivity and price requirements of non-professional and professional uranium prospectors and medical and industrial laboratory technicians. ★Simplest are "WF-10A" and "WF-11A" intended primarily for weekend and vacationing prospectors: weight 5 lbs. including batteries and carrying strap; weatherproof cabinet; three sensitivity scales (100, 1000 and 10,000 counts per minute); push-button resets to zero and prepares counter for a second reading to compare with accuracy of first reading; three-way indication of radioactivity: relative intensity scale in cpm, neon-light flashes and (if operator wishes) headphone. ★"WF-12A" and "WF-14A" are more versatile, with an external probe which aids in examining crevices, test bores, etc., and with a bismuth-type Geiger tube in "WF-14A." ★Supersensitive "WF-15A" contains ten Geiger tubes, is suitable for some types of prospecting from the air or

Circle **113** on inquiry card. ⟶

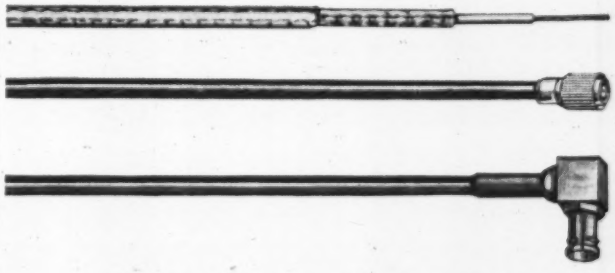
SAVE WEIGHT and SPACE

SUB*Minax*

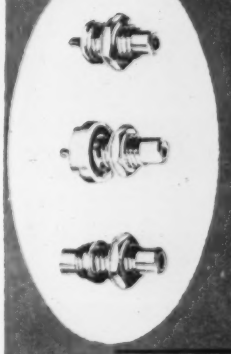


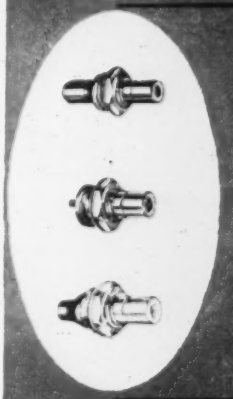
AMPHENOL

SUBMINIATURE RF CONNECTORS and SUBMINIATURE CABLE



Modern instrumentation demands top efficiency—in electrical performance and in mechanical design. New AMPHENOL Subminax RF connectors and cable meet this demand: Subminax are the smallest, most dependable rf components available. With Subminax you can obtain 500 circuits for each pound of weight—compared with 8 circuits for equivalent Series N rf connectors! 7 Subminax plugs occupy the same space as 1 Series N plug! Available in 50 ohm and 75 ohm *constant impedance.* Complete connector line, in either push-on or screw-on design, includes: straight and right angle plugs, jack, cable feed through, bulkhead jack and receptacle. Hermetic seal receptacle in screw-on couplings only.





Cable assemblies with AMPHENOL *subminiature coaxial cable easily accomplished with hand Crimping Tool—only two types needed for entire series.*

AMPHENOL

AMERICAN PHENOLIC CORPORATION
chicago 50, illinois
In Canada: AMPHENOL CANADA LTD., Toronto

from a moving vehicle; includes meter response control and cosmic-radiation cancellation. ★Most sensitive is "WF-16A" which can quantitatively measure radiation in certain types of surveys from the air and moving vehicles; withstands rapid temperature changes from below zero to 100°F encountered during a day's work at high elevations; is equipped with a bank of ten bismuth-type Geiger tubes; can be used with an external probe.—*Radio Corp. of America, Tube Div., Harrison, N. J.*

For more information circle **356** on inquiry card.

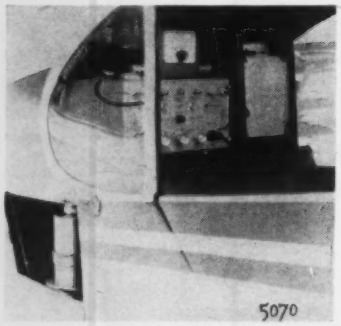
Scintillation Spectrometer

New "Model 513" is a complete system for precision analysis of various gamma-emitting radioisotopes, whether they occur singly or in mixtures or compounds; is designed for use by personnel not familiar with ordinary scintillation equipment. It includes maker's external bench-type Well Scintillation Detector and an equipment cabinet housing a shielded Linear Amplifier, Differential Pulse Height Analyzer, Pre-Set Time Scaler and Super-stable Scintillation High Voltage Supply.—*Atomic Instrument Co., 84 Massachusetts Ave., Cambridge 39, Mass.*

For more information circle **357** on inquiry card.

Survey System

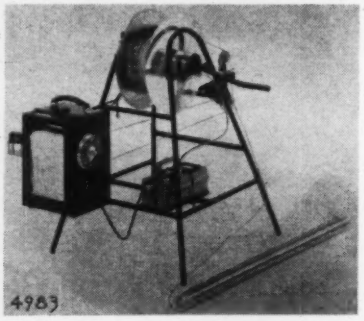
New "DS-7" scintillation survey system for aerial and ground radioactivity exploration consists of a scintillation detector with a 3-in sodium iodide crystal, a ratemeter, recorder, and buzzer alarm to alert pilot or observer; weighs less than 75 lbs and features low (60-watt) power consumption. Photo shows installation in light airplane.—*Nuclear Instrument and Chemical Corp., 229 W. Erie St., Chicago 10, Ill.*



For more information circle **358** on inquiry card.

Deep Drill Hole Logger

New "Deep Drill Hole Scintilogger" for radioactivity logging to 6000 ft. provides verified in-hole-out-hole radiation profiles which indicate deeply-buried uranium deposits and identify oil-productive zones in new wells as well as new productive zones in old wells.—*The Radiac Co., Inc., 489 Fifth Ave., New York 17, N. Y.*



For more information circle **359** on inquiry card.

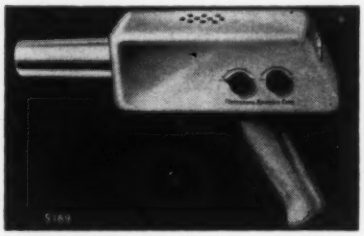
Transistorized Geiger Counters

New "miracle" Geiger counters feature packaged plug-in transistor power supply that give each instrument a 1000-hour life on two 1½-volt flashlight cells. Instruments are said to "weight less than half as much as any others of comparable style . . . read full scale on ordinary cosmic gamma rays . . . sell for less than present comparable models."—*Universal Atomics Corp., 19 E. 48th St., New York 17, N. Y.*

For more information circle **360** on inquiry card.

Survey Geiger Counter

New "Model 411," said to be "the first completely transistorized Geiger counter," weighs less than 4 lbs; gives audible signals in addition to visual readings in counts per minute and in milliroentgens per hour; operates on two 1½-v flashlight cells for over 500 hours on a continuous use basis.—*Universal Atomics Corp., 19 E. 48th St., New York 17, N. Y.*

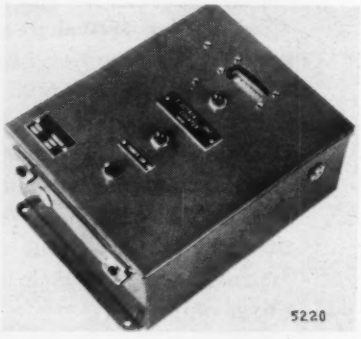


For more information circle **361** on inquiry card.

COUNTING and COMPUTING

Load-stroke Counter

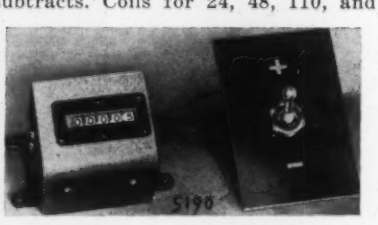
New "Electronic Load Counter" counts only load strokes of presses, shears, etc., can also be used with fatigue or cyclic testers to count cycles before failure. Pickup is of pressure type, can be located 100 ft away.—*Control Devices, Inc., 8209 East Nine Mile Road, Van Dyke, Mich.*



For more information circle **362** on inquiry card.

Two-way Counter

New "Series 1520 Counter" has two coils and actuating means. It adds or subtracts. Coils for 24, 48, 110, and 220 v ac or dc operation are available. Rate 700 counts per minute, and possibly higher (final information after completing tests of production units). Available with 3, 4, 5 or 6 figures, reset, or non-reset.—*Veeder-Root, Inc., Hartford 2, Conn.*



For more information circle **363** on inquiry card.

Electric Counter

New "Model 650 Rayconter" can display counts of 3600 per minute to 999,999, actuated over a pulsing circuit of any reasonable length, using either line or low voltage as specified.—*Raycon Corp., 226 Harbor Blvd., Belmont, Calif.*

For more information circle **364** on inquiry card.

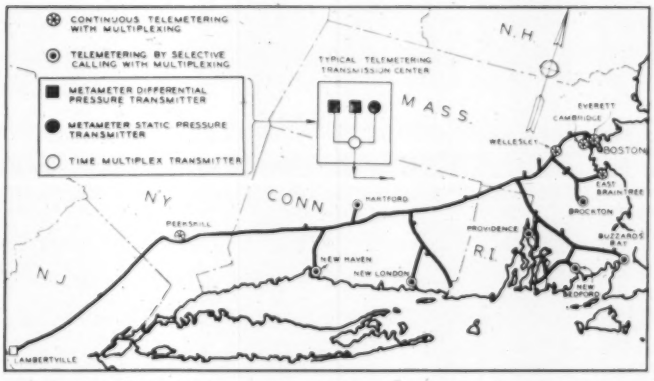
Paired Multipliers

New "Model 123 Servo Multiplier Group" consists of two "Model 123-1" single-channel servo multipliers and one "Model 123-2" power supply. Each servo channel is capable of multiplying 5 variable dc voltages by a sixth.

WHAT'S NEW AT BRISTOL...

EASY-TO-READ Bristol Metameter Telemeters at Algonquin Gas continuously record information on twelve measurements of static and differential pressures in the Boston area. Bristol Multiplex receivers (bottom row) segregate incoming signals and direct them to proper receivers.

Continuous, system-wide telemetering pays off for Algonquin Gas



MAP SHOWS Bristol telemetering equipment on the Algonquin Gas Company's pipeline.

Every gas company sells two commodities. Gas – and service. *Reliable* service. Service that builds confidence. Service that turns prospects into customers, customers into friends.

How to achieve this kind of service? The Algonquin Gas Transmission Company of Boston finds the answer in a Bristol Metameter® Multiplexing Telemetering system. With the help of the Bristol installation, Algonquin can supply gas to its customers at pressures which the customers have determined are best for their operation – with an absolute minimum of service discontinuities.

Why Bristol equipment? Because Algonquin felt it was simply good business to deal with the acknowledged leader in telemetering equipment. Let us tell you how Bristol's 65 years of instrument experience can help you, too. Write for Bulletin M1710 to The Bristol Company, 113 Bristol Road, Waterbury, Conn. 4.38

TRADE MARK BRISTOL'S REG U.S. PAT. OFFICE

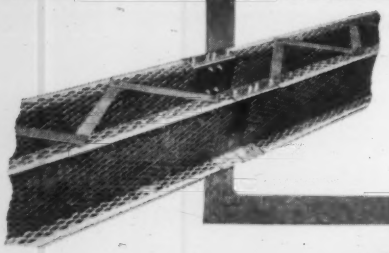
BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

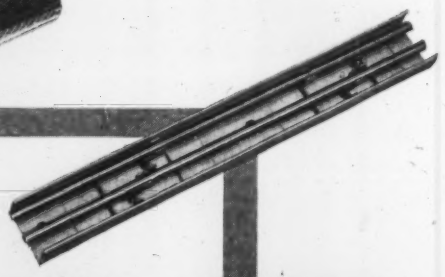
AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **114** on inquiry card.

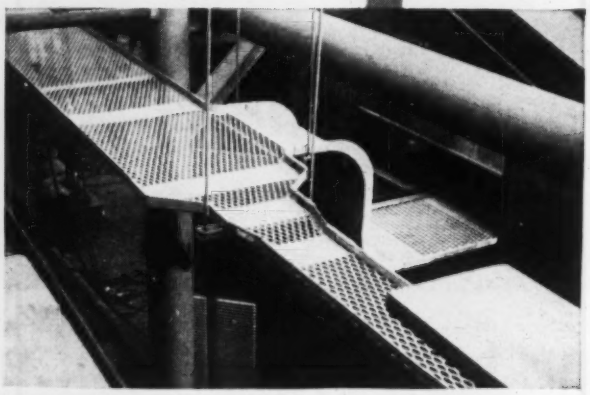
INSTROF
for the support of instrument tubing



BOX GIRDER—for long unsupported span lengths.



TUBE RACE—for branch run.



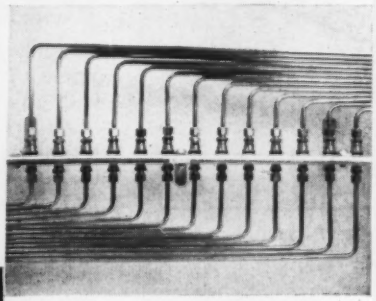
The Instrof System installed in a large South-West Coast Chemical Plant. All fittings are stock items which were rapidly assembled on the job. System is ready for placement of tubing.

Instrof is a system of prefabricated metal trough specifically designed to give continuous support and protection to instrument tubing. It is the most versatile system of its kind on the market today, and can be readily assembled at the job site in an extremely short time. Once installed, it requires no maintenance.

Instrof is available in widths of 3", 6", 9", 12", 18", and 24" with a complete range of fittings for all widths. These fittings enable the system to follow walls, change direction and elevation, and to change from one width to another—in short, to conform to any plant layout.

For further information on how the Instrof System can help solve your tubing problems, write today for the new Instrof Catalog. Ask for Bulletin I-8.

The Instrof Bulkhead Bar is a light section of channel with ¼" brass couplings mounted on 1½" center. It can be used wherever straight or angle tube terminal connections are required, such as junction boxes, panel boards, etc. It is especially adaptable to mounting on Instrof sections. The standard bar contains 40 ¼" brass couplings and is five feet long. Other sizes can be manufactured to customer's specifications.

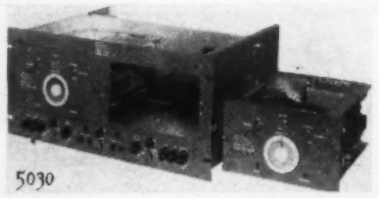


INSTROF
INCORPORATED

4923 PENTRIDGE ST.
PHILADELPHIA 43, PA.

For more information circle **115** on inquiry card.

NEW INSTRUMENTS



Servo channels can be provided with sine-cosine, secant, tangent or special non-linear function pots. Frequency response with 10% amplitude is flat to within ± 1 db to 5 cps and to within ± 3 db to 12 cps; dynamic accuracy 0.5% at 0.5 cps.—*Dynalysis Development Labs., Inc.*, 11941 *Wilshire Blvd, Los Angeles* 25, *Calif.*

For more information circle **365** on inquiry card.

Computer Tube

New "Type 6350" miniature T-6½ twin triode for use in high-speed digital computers, features high perveance, and good power handling; has a plate dissipation rating of 3.5 watts per section. Each section features a high zero-bias plate current, sharp cutoff and a separate cathode connection. Cathode is designed to operate at low temperature and special alloys used in its composition minimize sublimation and cathode interface formation.—*Sylvania Electric Products Inc., Emporium, Pa.*

For more information circle **366** on inquiry card.

Computer Storage Tube

New "6571" 3-inch storage tube, for use in binary-digital computer systems, is of single-beam type; utilizes electrostatic focus and deflection, has its storage surface on inner surface of faceplate (requires an external signal-output electrode in contact with entire area of faceplate). Redistribution writing and capacitance-discharge reading are employed. Storage surface has relatively uniform secondary emission to prevent "bad spots" on which information cannot be stored. Focused beam has exceptionally small effective area including fringe of low-density beam current and a well-defined boundary (especially significant whenever a single storage element is addressed several times before neighboring elements are regenerated).—*Radio Corp. of America, Tube Div., Harrison, N. J.*

For more information circle **367** on inquiry card.

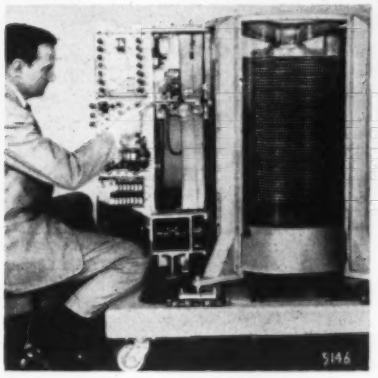
Electronic Computers

Two new "Univac-Scientific" computers, compatible with commercial "Univac" and "File-Computer," feature metal magnetic tape input medium instead of plastic tape which could not be used with maker's other models. General storage has been increased from 17,408 registers to 20,480, through replacement of 1024 electrostatic registers with 4,096 magnetic core registers (far more reliable and economical in operation). Basic equipment: photelectric tape reader, directly-connected electric typewriter, and high-speed tape punch; optional: card reader, card punch, Teletype communication circuits, graphic visual displays, analog-digital converters for use with measuring pickups, and signal circuits to process-actuating mechanisms.—*Remington Rand Inc.*, 315 *Fourth Ave., New York* 10, *N. Y.*

For more information circle **368** on inquiry card.

Random-access Memory

New "IBM 305" magnetic-disc random access memory stores five million characters, is said to "permit mechan-



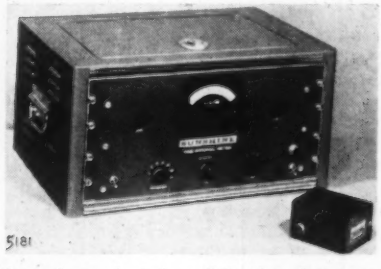
ization of accounting and record-keeping previously found impractical owing to costs or procedural problems."—*International Business Machines Corp.*, 590 *Madison Ave., New York* 22, *N. Y.*

For more information circle **369** on inquiry card.

TIME and SPEED

Time-interval Meter

New direct-reading electronic time-interval meter measures short time intervals (0.0001 sec to 3 sec): dura-



tion of an electric pulse, time between various combinations of positive and negative pulses or electric and light pulses. Accessories include a calibrator (which allows use of instrument as an instantaneous frequency meter),

BARBER COLMAN

New Wheelco Model 407 Capacitrol

. . . brings you extra benefits for electrically heated furnaces!

You can expect the finest temperature control available commercially when you specify this new Wheelco 407 Capacitrol. Here is a completely new form of "stepless" electric proportioning control . . . with ultra-sensitive action which eliminates "drift" in control point. Here is an instrument which maintains temperature within exceptionally fine tolerances . . . assures a constant output rate . . . and prevents the waste of power and fast depreciation of heating equipment caused by stop-and-go, on-off control.

GET NEW DATA BULLETIN

Get the complete story in Bulletin F-6314-1 which describes and illustrates the outstanding new design improvements exclusively found in Model 407. Start getting better quality heating at lower cost by sending your inquiry today.

WHEELCO INSTRUMENTS DIVISION

Barber-Colman Company

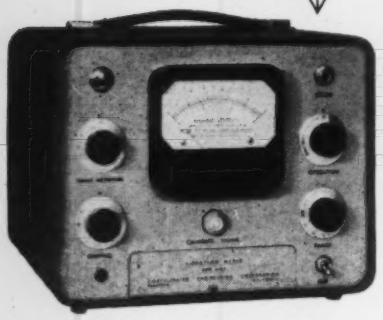
Dept. T, 1515 Rock Street, Rockford, Illinois

BARBER-COLMAN OF CANADA, LTD., DEPT. S, TORONTO, ONTARIO, CANADA

Industrial Instruments · Automatic Controls · Air Distribution Products · Aircraft Controls · Small Motors
Overdoors and Operators · Molded Products · Metal Cutting Tools · Machine Tools · Textile Machinery

For more information circle **116** on inquiry card.

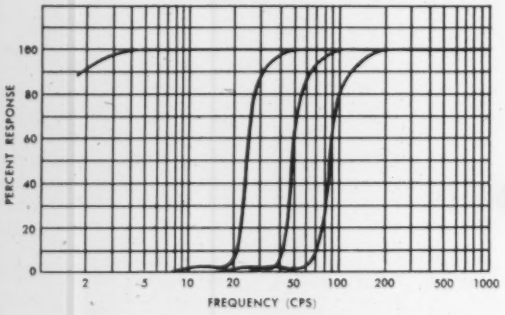
in one vibration meter...



...laboratory accuracy ...factory ruggedness

Use it for the most critical laboratory work ... then take it out on the production line for turbo-prop or jet-engine check-out. CEC's Type 1-117 does both, with a combination of accuracy and ruggedness not found in any other meter. It is particularly suitable for aircraft power plant vibration measurements ... can be used anywhere, even by inexperienced personnel. Coupled with any CEC precision vibration pickup, the 1-117's outstanding flexibility makes it the ideal *general-purpose* system for measurement or monitoring.

Pickups are available for either linear or torsional vibration measurements.



Plug-in filters permit optional cutoff of low-frequency vibrations at 30, 70 or 110 cps. . . . give you *four meters in one.* Send for Bulletin CEC 1538A-X1.

When the 1-117's great versatility is not needed, investigate CEC's economical Type 1-110B Vibration Meter ... standard of industry and aviation for over 10 years. Bulletin CEC 1505C-X1.

Consolidated Engineering

Corporation

ELECTRONIC INSTRUMENTS FOR MEASUREMENT AND CONTROL

300 North Sierra Madre Villa, Pasadena 15, California

Sales and Service Offices Located in: Albuquerque, Atlanta, Buffalo, Chicago, Dallas, Detroit, New York, Pasadena, Philadelphia, Seattle, Washington, D. C.

For more information circle **117** on inquiry card.

a photoelectric receiver, and a light source.—*Sunshine Scientific Instrument,* 1810 *Grant Ave., Philadelphia* 15, *Pa.*

For more information circle **370** on inquiry card.

Time Meter

New "Timeter" registers total operating hours of any electrical equipment or motor-driven machine, by tenths of hours or minutes, then repeats. Knob under protective cap governs multiple-reset odometers, permitting resetting in not more than two revolutions. "Timeter" can be supplied with registration up to 99,999.9 hours or minutes. Application is independent of size of load.—*Capeway Instrument Corp., Bedford St., East Bridgewater, Mass.*

For more information circle **371** on inquiry card.

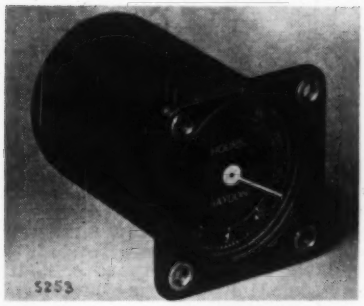
Arc Time Totalizer

New Arc-Time Totalizer registers duration of arc-current; is said to operate with "an accuracy never before attainable" owing to its no-moving-parts construction; is completely fool-proof; current leakage, or any current below a specified amount, will not register. Principle: current passing through a coiled welding cable sets up a magnetic field which triggers a vacuum diode when a specified current flows through coil. Triggering action activates ac circuit and relay starts clock. When current falls below a specified amount, diode is again triggered, stopping clock. Two models: "Model 146" (photo) having one register, totalizes only time arc current is in use; "Model 150" has a second register to totalize time welding generator is in operation, so that ratio of two times indicates efficiency of welding operation.—*Exline Engineering Co.,* 1636 *East 6th St., Tulsa, Okla.*

For more information circle **372** on inquiry card.

Elapsed-time Indicator

New "Model 7008 Running Time Meter" indicates hours-of-operation up to 10,000 hr on a dial-type face; weighs less than 6 oz; has a power drain of about 2 watts; is hermetically sealed in accordance with MIL-I-7793 (AER); meets military shock (25 g) and vibration requirements. Body diameter 1½ in, length 2¾ in. Unit mounts either behind or in front of mounting panel. Electrical connections from back through solder type

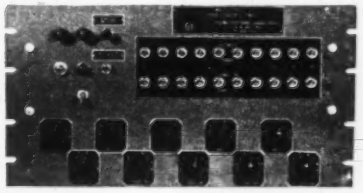


glass-to-metal sealed terminals. Concentric hands, as in a clock, permit reading to better than ten-hour accuracy.—*Haydon Mfg. Co.*, 245 *E. Elm St., Torrington, Conn.*

For more information circle **373** on inquiry card.

Sequence Timer

New automatic timer for controlling a sequence of events comprises ten stages, each variable from 10 mil-



liseconds to 2 sec in ten steps and controlled either automatically or manually by switches on front panel; also contains 5 dpdt operating relays and a power source of 77 vdc for their operation. All relay coil and contact connections are brought out to patchboard on rear panel for easy changing of sequences. Timer can be commanded optionally by a remote-control unit.—*Chicago Electronic Labs.*, 1214 *W. Madison St., Chicago 7, Ill.*

For more information circle **374** on inquiry card.

Electronic Tachometer

New "Catalog No. 19" features tuning-fork reference; accuracy 0.2% (0.1% with calibration curve). Input

can be a phototube and light source (available with tachometer), an interrupter, or a conventional a-c electric tachometer generator. No mechanical connection to rotating shaft; readings instantaneous and continuous. Switching arrangement provides incremental readings on a meter; and a strip-chart recorder can be actuated.—*Sunshine Scientific Instrument*, 1810 *Grant Ave., Philadelphia* 15, *Pa.*

For more information circle **375** on inquiry card.

Speed Reducer

New "DOX" small horizontal double-reduction speed reducer with zinc alloy housing is available in ratios of 4:1 to 1600:1; torque capacities of 25 lb-in to 150 lb-in utilizing 1/6 hp. Standard "DOX" reducers furnished with roller bearings; bronze sleeve bearings are available. —*Ohio Gear Co.*, 1333 *East* 179 *St., Cleveland* 10, *Ohio.*

For more information circle **376** on inquiry card.

Motor Speed Controller

New "Type RM5" provides stepless reversible adjustable speed operation of dc shunt wound motors rated up to 1/15 hp; operates directly from existing single phase ac. power lines and maintains constant torque over a wide speed range. Standard dc motors can

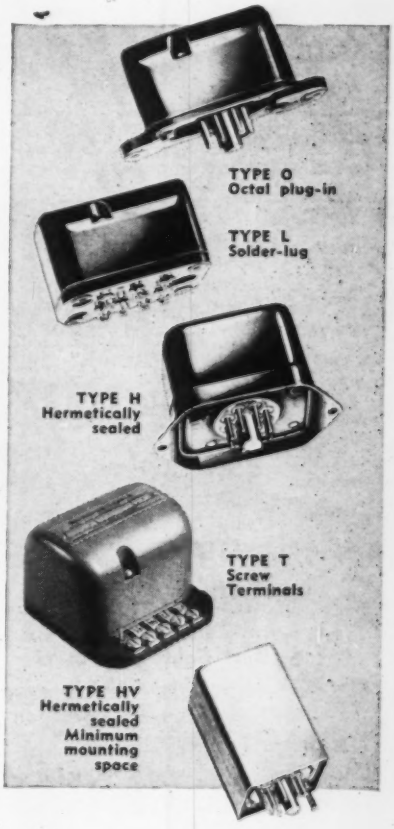
CORRECTION

New-product item on The A. H. Emery Company's large-dial pressure gage (April 1955 *Instruments and Automation*, page 548). Accuracy figure of "2 percent" was printed as it appeared in the mimeographed new-product announcement; but the maker informs us that it should have read "0.2 percent."

BARBER COLMAN

ultra-sensitive relays

help solve control problems in wide range of industrial applications



Operating on input powers of 50 to 1000 microwatts, the Barber-Colman Micropositioner is ideal for use as a null detector in resistance bridge circuits, a differential relay in electronic plate circuits, and an amplifier in photo-electric circuits. Standard contact arrangement is SPDT, null seeking. Can be operated in excess of 100 cps. This ultra-sensitive polarized d-c relay has been widely used in many control applications . . . in nucleonics, communications, instrumentation, process control, railway signal transmission, and aircraft temperature control and remote positioning. Write for Bulletin F 3961-4.

Barber-Colman Company
Dept. T, 1415 Rock Street, Rockford, Illinois

For more information circle **118** on inquiry card.

CHECK ALL TENSIONS

with the new Trigger

SAXL TENSION METER

Quickly—Correctly In Small Space

METERS FOR WIRES YARNS, LASTEX, etc.

TENSITRON, INC.
HARVARD, MASSACHUSETTS

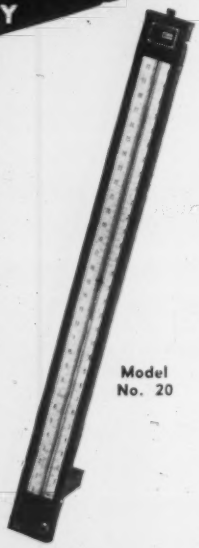
Some territories still open for qualified representatives

For more information circle **220** on inquiry card.

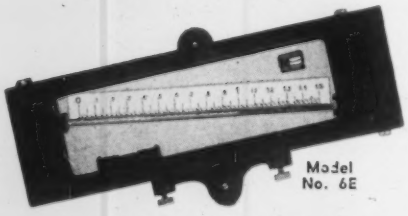
Trimount
MANOMETERS
• EASY READING
• ACCURATE
• STURDY

WELL TYPE MANOMETERS

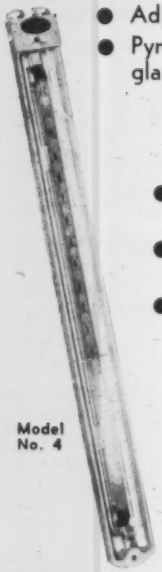
- Welded steel channel
- Enclosed plate glass cover
- Red Line Pyrex tube
- Front Zero adjustment


Model No. 20

DRAFT GAUGES
with Wall Mounting Brackets


Model No. 6E

- Dust tight glass cover
- Adjustable scale
- Pyrex tube—compression gland packed


Model No. 4

SLIDING SCALE U-TUBE MANOMETERS

- Cast aluminum channel
- Heavy Pyrex U tubes
- Leak proof compression type glands

Write for latest bulletin E showing our complete line of Manometers. Contact us for custom made designs to help you solve your problems.

See our display at the Instrument Show, Los Angeles, Sept. 12-16 in the Western Control Equipment Company's Booth B-314

Trimount
INSTRUMENT CO.
3119 WEST LAKE STREET • CHICAGO 12, ILLINOIS

For more information circle **119** on inquiry card.

be operated through a working range of several hundred to one; small motors with base speeds of 5,000 to 10,000 rpm can be used through a speed range of as much as 1000:1.—*Opad Electric Co., 69 Murray St., New York 7, N. Y.*

For more information circle **377** on inquiry card.

ELECTRICAL MEASURING INSTRUMENTS

Digital Ohmmeter

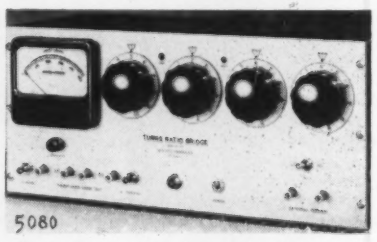
New "Model DO40" is a self-balancing bridge that displays 4 digits accurate to 0.05% ± 1 digit from 0.1

ohm to 1 megohm in four ranges. Range is indicated by a lighted automatically-located decimal point and by symbol Ω or KΩ in extreme right window. Average reading time about 1 second.—*Electro Instruments, Inc., 3794 Rosecrans, San Diego 10, Calif.*

For more information circle **378** on inquiry card.

Turns Ratio Bridge

New "Model MC-127" is fed from an *RC* type audio generator and amplifier; has two unknown transformer

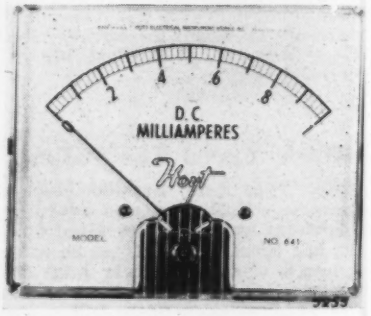

5080

windings in two legs. Ratio-division resistors are in third leg and balancing decade resistor is in fourth. Bridge ratio arms are accurate to 0.1%. Normal operation indicates a single turn in a thousand.—*Specific Products, 14515 Dickens St., Sherman Oaks, Calif.*

For more information circle **379** on inquiry card.

Milliammeter

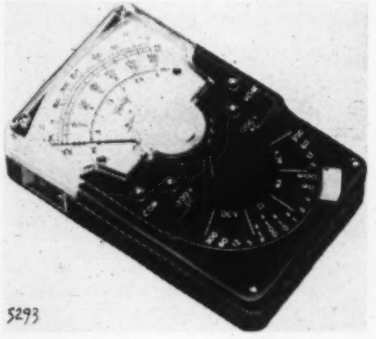
New "No. 641" milliammeter, available for either ac or dc in all standard ranges, features clear polystyrene case and 4½-in scale; provides 4% additional dial area for multi-band scales. Case is anti-static treated and available with either 4-stud or 2-stud mountings. Jewel-bearing movements of d'Arsonval or repulsion.—*Burton-Rogers Co., Sales Div., Hoyt Electrical Instrument Works, 42 Carleton St., Cambridge 42, Mass.*



For more information circle **380** on inquiry card.

Miniature VOM

New "Model 310 Mighty Mite," said to be "the first and only complete miniature 20,000 ohms per volt V-O-M

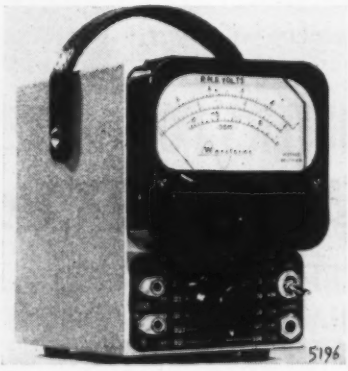

5293

available for the technician who wants a pocket-size unit suitable for wide-range testing," weighs 14 oz with battery; is self-shielded for checking in strong magnetic fields, has interchangeable test prod tips that fit in top of unit to become common probe. Ranges: dc volts: 0-3-12-60-300-1200 at 20,000 ohms/volt; ac volts: 0-3-12-60-300-1200 at 5,000 ohms/volt.—*Triplett Electrical Instrument Co., Harmon Ave., Bluffton, Ohio.*

For more information circle **381** on inquiry card.

Extended-range Voltmeter

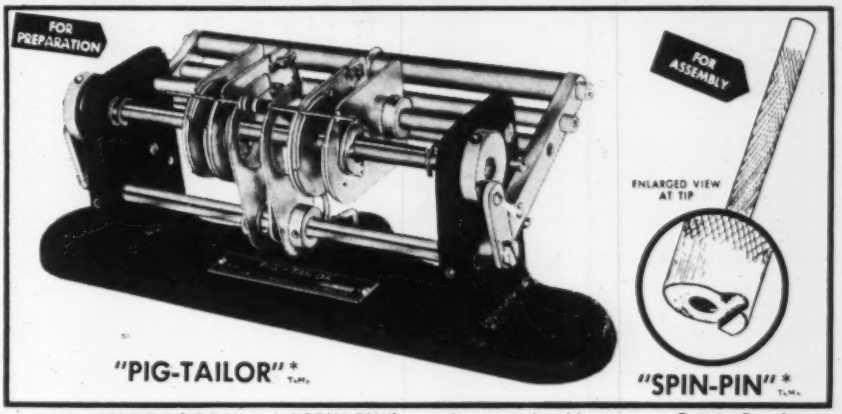
New "520-A" performs as voltmeter, null indicator, and 60-db decade amplifier independently of line voltage interference and external stray fields "to an unprecedented degree"; operates on 50-400-cps power line frequencies; has full-scale sensitivity of 1 millivolt permitting measurements as low as 100 microvolts (useful in-


5196

"PIG-TAILORING"

. . . . a revolutionary new mechanical process for higher production at lower costs. Fastest PREPARATION and ASSEMBLY of Resistors, Capacitors, Diodes and all other axial lead components for TERMINAL BOARDS, PRINTED CIRCUITS and MINIATURIZED ASSEMBLIES.

● ● ● ● ●



The "PIG-TAILOR" plus "SPIN-PIN" — Accurately Measures, Cuts, Bends, Ejects and Assembles both leads simultaneously to individual lengths and shapes — 3 minute set-up — No accessories — Foot operated — 1 hour training time.

PIG-TAILORING provides:		PIG-TAILORING eliminates:	
1. Uniform component position.	6. Individual cut and bend lengths.	1. Diagonal cutters.	6. Broken leads.
2. Uniform marking exposure.	7. Better time/rate analysis.	2. Long-nose pliers.	7. Short circuits from clippings.
3. Miniaturization spacing control.	8. Closer cost control.	3. Operator judgment.	8. 65% chassis handling.
4. "S" leads for terminals.	9. Invaluable labor saving.	4. 90% operator training time.	9. Excessive lead tautness.
5. "U" leads for printed circuits.	10. Immediate cost recovery.	5. Broken components.	10. Haphazard assembly methods.

* PATENT PENDING

Write for illustrated, descriptive text on "PIG-TAILORING" to Dept IA8-P

BRUNO-NEW YORK INDUSTRIES CORPORATION

DESIGNERS AND MANUFACTURERS OF ELECTRONIC EQUIPMENT

460 WEST 34th STREET • NEW YORK 1, N. Y.

For more information circle **120** on inquiry card.

---

news notes from Berkeley division

BECKMAN

FREE DATA FILE

"A Digital Method for Precise Phase Measurements"
by ROBERT S. MELSHEIMER

Complete data on techniques for precise phase measurements by digital means, as used for synchro and resolver calibration, servo system testing, low frequency response studies, etc. Also includes comprehensive discussion of digital measurement accuracies.

Write now for free copy; please request Data File No. 107, address Dept. B-8.

Berkeley *division*
BECKMAN INSTRUMENTS INC.
2200 Wright Avenue • Richmond 3, Calif.

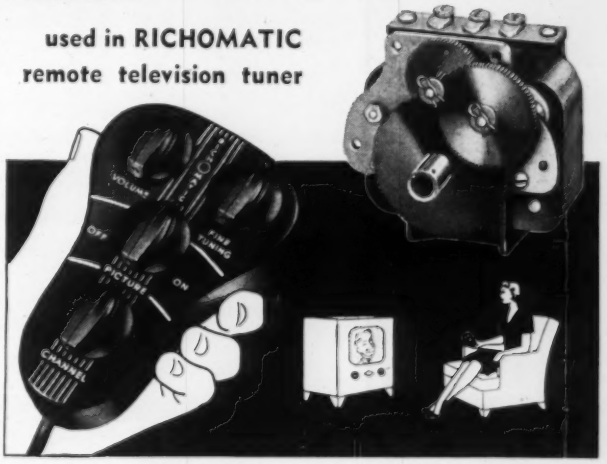
58

For more information circle **121** on inquiry card.

BARBER COLMAN

Small Motors

used in RICHOMATIC remote television tuner



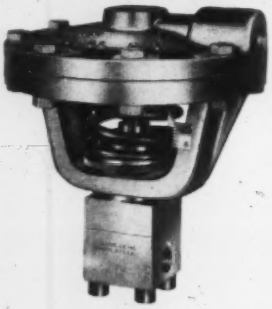
With a "Rich O Matic" television remote control, the TV viewer can sit in his chair and turn the set on and off, change stations, adjust volume, picture and tuning. Coil tuner is operated by a Barber-Colman type EYAZ geared reversible motor. For reliable, accurate actuation of your products or instruments, too, there's a wide line of high-torque Barber-Colman motors up to 1/20 hp. Unidirectional, synchronous, and reversible . . . with or without gearing . . . open or enclosed. Write for data sheets.

Barber-Colman Company Dept. T, 1215 Rock St., Rockford, Ill.

For more information circle **122** on inquiry card.

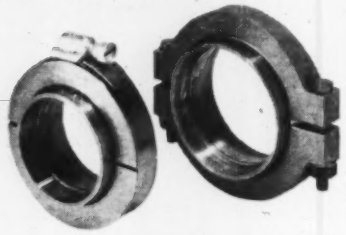
MINIATURIZATION

From Pilot Plant to Process



"BANTAM" 500 SERIES

Throttling "Bantam" Diaphragm Control Valves for all standard control valve uses, Cv of 0.6 and below, up to 1000 psi and 500°F, characterized, renewable trim, 31(stainless steel and teflon only wetted sur faces, low in hysteresis, size and weight a modern design of control valve. 200(series "Bantam" Control Valves available for on-off service.

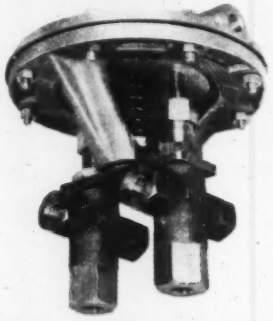


TUBE AND PIPE CONNECTORS

For use in such systems as aircraft or marine applications where weight is a factor, these connectors replace standard flanges. Available in various materials, in male or female socket or butt weld design, for tubing, and up to schedule 40 pipe.

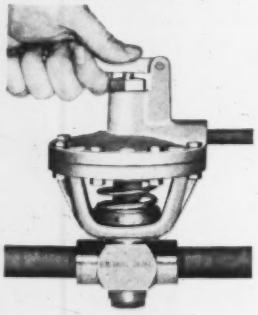
"DEMI" PACKLESS VALVES

For services when packing is a problem, manifolding of small valves in one unit, these low cost valves have a great popularity. For services up to 1500 psi and 500°F., screw, toggle, or diaphragm operated, the "Demi" line is ideal for panel mounting up to five valves in one block.



WHIFFLETREE OPERATOR

Two valves operated simultaneously by one operator. Valves may be globe or three-way and have a multitude of piping arrangements for mixing and routing applications.



MANUAL RESET

Wherever control air on dangerous or toxic process flows must be blocked for safety, on air failure until manually reset, these valves insure against disaster. Standard sizes ¼" and ½" I.P.S.

SAUNDERS VALVES — AIR OPERATED

Plastic valves, 2" and below, metal valves 1" and below, G. W. Dahl Company, Inc. diaphragm operators on these valves provide simple, sure automatic operation. Each application must submit full flow information.

Write us for complete technical information, or the address of our representative in your area.

George W. DAHL Company

BRISTOL, RHODE ISLAND

See Your Packless "Demi" Values assembled and tested, Booth B-306.

Instrument-Automation Conference & Exhibit, Los Angeles, Calif., Sept. 12-16, 1955

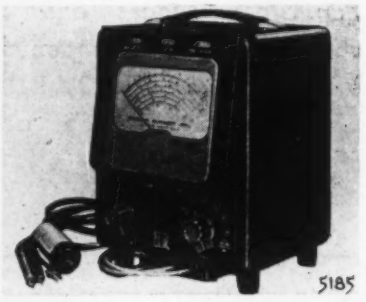
For more information circle **123** on inquiry card.

dications at still lower levels). Ranges up to 300 volts, and from −72 to +52 dbm.—*Waveforms, Inc., 333 Sixth Ave., New York 14, N. Y.*

For more information circle **382** on inquiry card.

Vacuum-tube Voltmeter

New "Type 800-A," for extended-range voltage, resistance, and current measurements, has highly degenerative amplifier circuit said to provide



previously unachieved stability. Reads ac voltage (15 cps to 100Mc) eight ranges 0.1 to 300 volts; nine dc voltage scales 0.1 to 1000 volts; resistances 0.2 to 500 ohms with nine multipliers from X0.1 to X10 meg, and nine direct current ranges 0.001 microamp to 100 ma.—*Technology Instrument Corp., 531 Main St., Acton, Mass.*

For more information circle **383** on inquiry card.

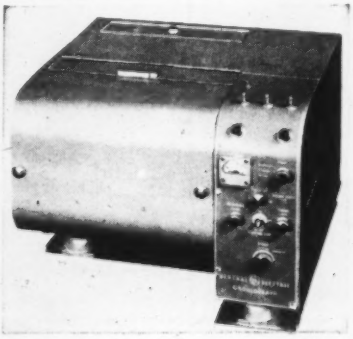
Portable Oscilloscope

New "Type 310" is a dc-to-4-Mc portable (23½-lb) instrument for both field and lab. Features include: Wide-range sweep circuit—0.5 usec/div to 0.6 sec/div; accuracy within 3%; 5x magnifier; trigger amplitude selection or automatic triggering; dc-coupled unblanking; vertical amplifier rise-time 0.09 usec; accurately calibrated sensitivity from 0.1 v/div to 50 v/div; sensitivity continuously variable from 0.01 v/div to 150 v/div; square-wave voltage calibrator; 1.85-kv accelerating potential on 3-in. crt; regulated power supply. Operates on 105/125 v 60 to 800 cps.—*Tektronix, Inc., P. O. Box 831, Portland 7, Ore.*

For more information circle **384** on inquiry card.

Oscillograph

New "PM-20" general-purpose oscillograph for static or dynamic testing of all types of industrial or aircraft equipment will record up to 71 individual variables on one oscillogram



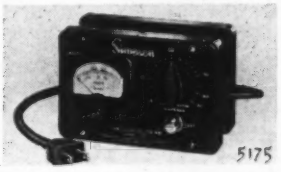
when combined with suitable pickups and amplifiers for measurement of pressure, vibration, strain, flow, etc. Automatic shutter closes as 100-ft record holder is released from oscillograph, reducing possibility of fogging records during transportation. Alnico magnets in ends of spools make possible rapid snap-in positioning of spools even in darkness.—*Instrument Dep't, General Electric Co., West Lynn 3, Mass.*

For more information circle **385** on inquiry card.

ELECTRICAL TESTING EQUIPMENT

Line-quality Tester

New "Model 397 Line Current-capacity Tester" determines adequacy (or inadequacy) of a 115-volt power



line to furnish any value of motor-starting current from 13 to 50 amperes.—*Simpson Electric Co., 5200 W. Kinzie St., Chicago 44, Ill.*

For more information circle **336** on inquiry card.

Battery Tester

New "Model 584," designed as a battery sales merchandising aid as well as a tester of new, used inventory batteries, tests all A and B portable radio batteries and equivalent types under actual receiver conditions without requiring them to be installed in the equipment; also tests hearing-aid, lantern and radiation counter batteries, and has a spare position for adaptation to testing other types.—*Electronic Instrument Co., Inc., 84 Withers St., Brooklyn 11, N. Y.*

For more information circle **387** on inquiry card.

Tester-rejuvenator for Cathode-ray Tubes

New "Model 101F Cathode-Rejuvenator-Cathode Ray Tube Tester" not only tests CRTs but also repairs them; is said to "embody an array of features never before combined in a single instrument." Rejuvenation process provides assurance of rejuvenation accuracy, with grid structures unharmed during processing. Available in 8x8x3 in gray steel case, or in luggage-type case with space for leads.—*Authorized Mfg. Co., 919 Wyckoff Ave., Brooklyn 27, N. Y.*

For more information circle **388** on inquiry card.

Millimicroammeter for Insulation Tests, etc.

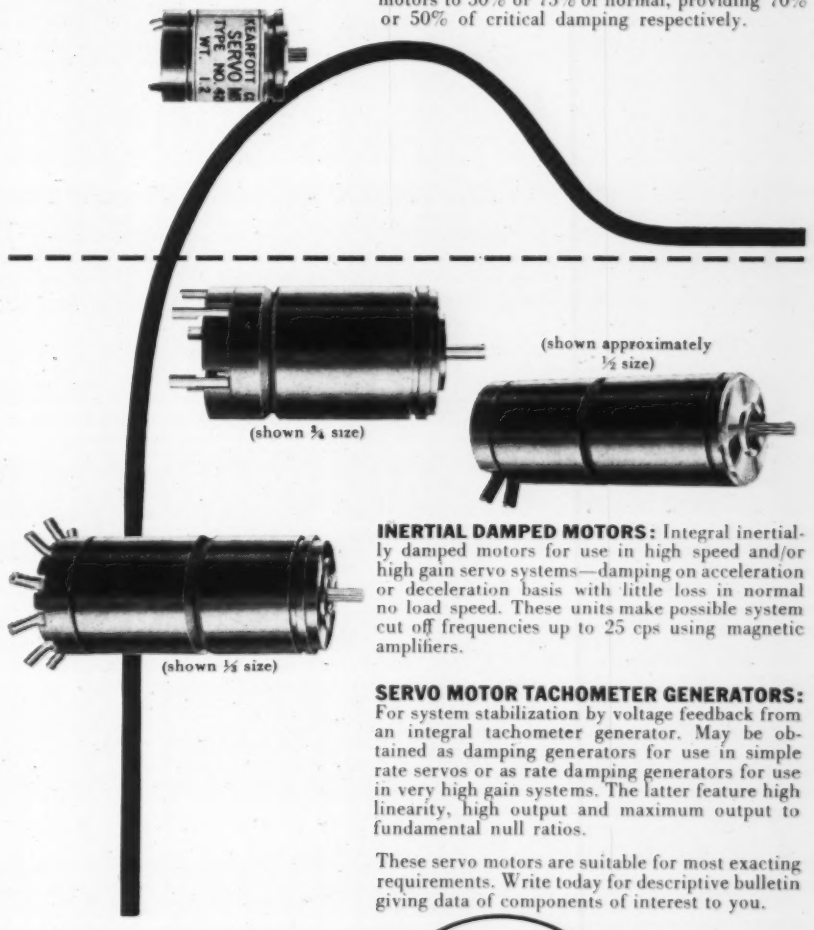
New "Model 63 TAKK Ultra Sensitive Current Meter," for measurement of leakage currents through insulation at any voltage level, weighs 8 lbs; measures only 9 x 6 x 5½ in.; measures direct currents from 0.001 to 1000 microamperes with accuracy said to be "previously obtainable only

There is no one "cure all" for system instability. The desired stability of a servo loop is attained through the proper selection of components that satisfy the various conditions under which the loop will operate. Kearfott offers four basic motors and combinations for providing system stability. All feature high speed of response; low inertia and high stall torque.

SYSTEM STABILITY

SERVO MOTORS: Servo motors with high torque to inertia characteristics possessing (built-in) inherent damping ranging in size from ¾" to 1¾" diameter are available. Low speed, low power motors for use in simple instrument servos where high damping and/or low time constant is required can also be provided.

VISCOUS DAMPED SERVO MOTORS: Provide integral viscous damping for simple instrument servos. Any degree of damping can be provided. These units reduce no load speed of standard motors to 50% or 75% of normal, providing 70% or 50% of critical damping respectively.



INERTIAL DAMPED MOTORS: Integral inertially damped motors for use in high speed and/or high gain servo systems—damping on acceleration or deceleration basis with little loss in normal no load speed. These units make possible system cut off frequencies up to 25 cps using magnetic amplifiers.

SERVO MOTOR TACHOMETER GENERATORS: For system stabilization by voltage feedback from an integral tachometer generator. May be obtained as damping generators for use in simple rate servos or as rate damping generators for use in very high gain systems. The latter feature high linearity, high output and maximum output to fundamental null ratios.

These servo motors are suitable for most exacting requirements. Write today for descriptive bulletin giving data of components of interest to you.

KEARFOTT COMPONENTS INCLUDE:

Gyros, Servo Motors, Synchros, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Aircraft Navigational Systems, and other high accuracy mechanical, electrical and electronic components.

Kearfott

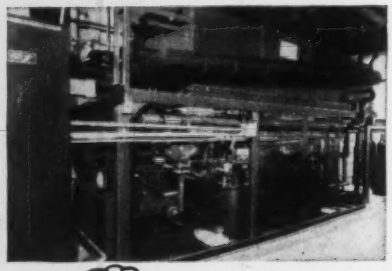
A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.

Sales and Engineering Offices: 1378 Main Avenue, Clifton, N. J.
Midwest Office: 188 W. Randolph Street, Chicago, Ill. South Central Office: 6115 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

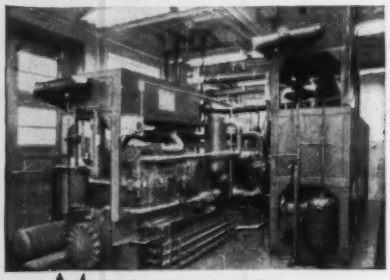
For more information circle **124** on inquiry card.

AR★
conditions
AIR & LIQUID
for
TEST
FACILITIES



AIR CHILLER

Provides 4 to 50 lbs. or more of air per minute at −70° F or lower continuously without dryers at pressures to 15 psi or higher. Elevated temperatures also available. Rapid raising and lowering of temperature can be provided as well as vacuum pump equipment for simulating cold air at high altitudes. Complete unit custom designed with automatic defrost.



LIQUID CHILLER

Conditions any liquid — fuel, corrosive or non-corrosive — at pressures to 1000 psi and higher with flows of 100,000 lbs. per hour if required. Temperatures of −70° F or lower or elevated temperatures if required.

Other American Research test facilities include simulation of **Altitude, Temperature** and **Humidity** in any combination, **Sand and Dust, Explosion, Rain and Sunshine** and **Fungus,** as well as **Industrial Processing Equipment** and a new line of **Hydraulic Test Stands.**

Write for complete catalog.

AMERICAN RESEARCH
CORPORATION
383 BROOK ST. BRISTOL, CONN.

For more information circle **125** on inquiry card.

NEW INSTRUMENTS

with a delicate suspension galvanometer." Resistance measurements up to 150,000,000 megohms can also be made. "Model 63" is suitable for determining condition of insulation and for other applications in industry and research. With a suitable multiplier resistor, it can be used as a high-resistance voltmeter (up to 100 megohms per volt).—*The Hewson Co., Inc.,* 443 *Broad St., Newark* 2, *N. J.*

For more information circle **389** on inquiry card.

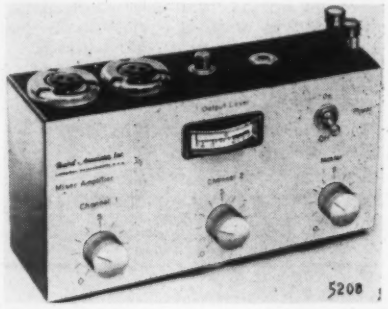
Pulsed Carrier Generator

New "Rada-Pulser Sr." can be used as a pulsed carrier, variable-CW or video-pulse generator; covers 12 to 80 Mc. range in five overlapping bands; provides a wide choice of pulse widths and repetition rates; can also be used with an oscilloscope or synchroscope to obtain a display of steady-state and transient response of RF and IF amplifiers; is designed for rack mountings.—*Kay Electric Co.,* 14 *Maple Ave., Pine Brook, N. J.*

For more information circle **390** on inquiry card.

Mixer-amplifier

New "Model JG1" portable transistorized mixer-amplifier is a field pickup unit designed primarily for

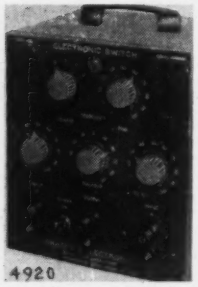


broadcasting and recording use. Power supply: ten hearing aid mercury cells. High level mixing by two input preamplifiers followed by two stages of stable amplification.—*Baird Associates, Inc.,* 33 *University Rd., Cambridge* 38, *Mass.*

For more information circle **391** on inquiry card.

ELECTRICAL-INSTRUMENT ACCESSORIES

Electronic Switch

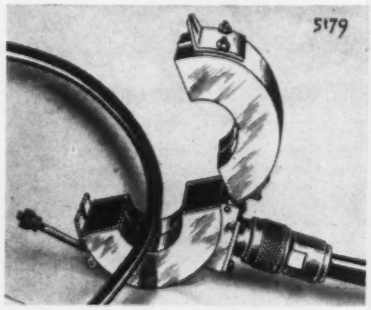


New "Type 650" is a portable (10-lb) instrument which makes possible simultaneous observation of two recurrent patterns on one 'scope screen. Relative positions of pattern can be varied so that they are superposed on each other or separated by a desired amount. Switching rate continuously variable from 10 to 20,000 per second.—*Chatham Electronics Div., Gera Corp., Livingston, N. J.*

For more information circle **392** on inquiry card

Conductor R-f Probe

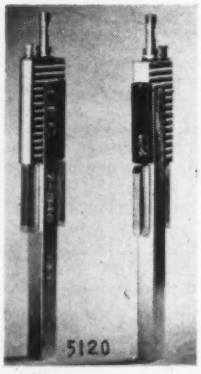
New "91129-1 Current Probe" does not require direct connection to conductor being investigated for radio-frequency current and interference.



It has a nominal output impedance of 50 ohms; is usable from 20 cps to 25 Mc. and rejects any external pickup from conductors not passing through window.—*Stoddart Aircraft Radio Co., Inc.,* 6644 *Santa Monica Blvd., Hollywood* 38, *Calif.*

For more information circle **393** on inquiry card.

Oscillograph Galvanometers



New "High-Performance" galvanometers permit accurate recording of dynamic signals up to 200 cps without amplifiers. Types are available for direct connection to commonly-used 120, 180, and 350-ohm strain gages and resistance-type pickups. Some are electrically interchangeable with maker's "7-300" units; others feature exceptionally high sensitivity.—*Consolidated Engineering Corp., Pasadena* 15, *Calif.*

For more information circle **394** on inquiry card.

Band-pass Filter

New "Model 310-AB" is a continuously-adjustable filter with unity pass band gain and 24 db/octave slopes

outside pass band. Peaking is used to reduce attenuation at cut-off frequencies. High and low cut-off frequencies independently adjustable from 20 cps to 200 kc, providing maximal flexibility of adjustment of band

"SERV-RITE" THERMOCOUPLE HEAD

the head that's ahead in every way . . .

This new "Serv-Rite" thermocouple head is actually small enough to be held comfortably in the palm of your hand. But size is only one of the many features that make this thermocouple head really extraordinary. It is loaded with installation and service conveniences that any user of thermocouples will appreciate at once.

The body is of malleable iron, cadmium plated for durability. A new type friction lock assures easy removal or tightening of the cap — a quarter turn does it. An asbestos gasket makes the head dirt- and moisture-proof. With a choice of ½", ¾", or 1" IPS opening for the protecting tube, you can standardize on one style head.

The connector block is of a material especially selected to withstand, without damage, temperatures up to 900° F. in continuous service. Improvements over the conventional type of inserts greatly simplify the making of the lead wire connections. The complete thermocouple element, including connector block, can be easily withdrawn for inspection.

Install a "Serv-Rite" thermocouple head and see for yourself how much better it really is.

Write for complete details

5606

GORDON SERVICE

CLAUD S. GORDON CO.

Manufacturers • Engineers • Distributors

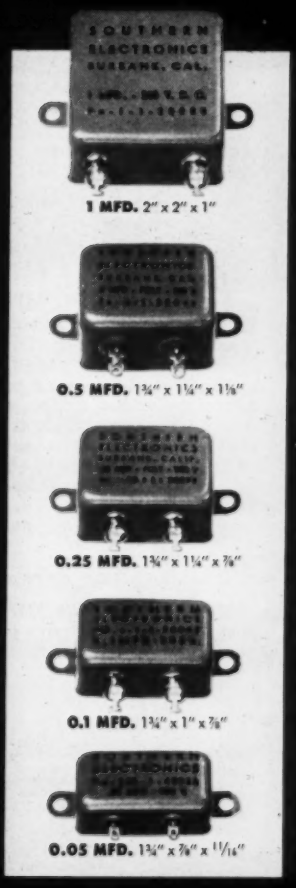
Thermocouples & Accessories • Temperature Control Instruments • Industrial Furnaces & Ovens Metallurgical Testing Machines

609 West 30th Street, Chicago 16, Illinois
2025 Hamilton Avenue, Cleveland 14, Ohio

For more information circle **126** on inquiry card.

NOW! ULTRA-HIGH PRECISION POLYSTYRENE CAPACITORS

as low as 0.1% tolerance in most values!



1 MFD. 2" x 2" x 1"

0.5 MFD. 1¾" x 1¼" x 1⅛"

0.25 MFD. 1¾" x 1¼" x ⅞"

0.1 MFD. 1¾" x 1" x ⅞"

0.05 MFD. 1¾" x ⅞" x 11/16"

Check these outstanding features:

- Capacitance Available – 0.05 to 10.0 MFD
- Voltage Available – 100 to 400 VDC
- Insulation Resistance – 10^6 MEG./MFD
- Temp. Coeff. – 100 P.P.M. per °C (–20° to 140° F)
- Dielectric Absorption – .015%
- Dissipation – .0002

Special values to close tolerances – our specialty

Join these other leading firms in specifying Southern Electronics' precision polystyrene capacitors for your most exacting requirements: Reeves Instrument Corp., Electronic Associates, Inc., Convair, Berkeley Scientific, M.I.T., Calif. Inst. of Tech., and many others.

Write for complete catalog –

POLYCON SEC MYCON

SOUTHERN ELECTRONICS *Corporation*

239 West Orange Grove Ave., Burbank, Calif.

Visit us in booth #333 Wescon Show Aug. 24-26, San Francisco

For more information circle **127** on inquiry card.

PALMER

presents

an outstanding improvement in

DIAL THERMOMETERS

external calibration

Full 3½" Dial Face

- No Sector
- No Pinion
- No Linkage
- Constant Accuracy
- Easy Readability

Consult Your Classified Directory

WRITE FOR BULLETIN 350

PALMER

THERMOMETERS, INC.

Norwood Ave., Cincinnati 17, Ohio

Mfrs. of Industrial Laboratory Recording and Dial Thermometers

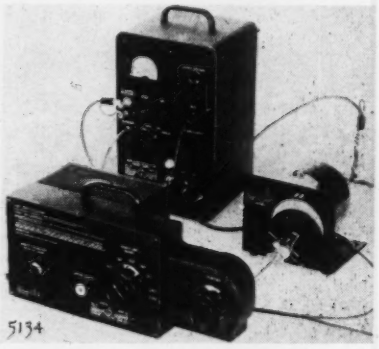
For more information circle **128** on inquiry card.

center frequency and band width. Internal hum and noise less than 1 millivolt. Calibration accuracy 10% (±5% available on special order).—*Krohn-Hite Instrument Co.*, 580 *Massachusetts Ave., Cambridge* 39, *Mass.*

For more information circle **395** on inquiry card.

Oscillator Sweep-drive

New "Type 1750-A Sweep Drive" replaces point-by-point frequency analyses by using a mechanical hand which turns an oscillator dial back

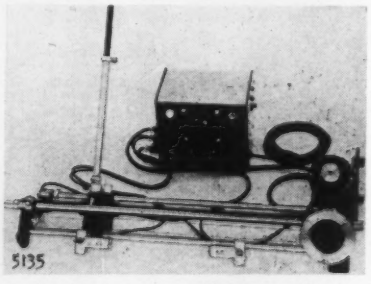


and forth. Speed is adjustable from ½ to 5 cycles per second; sweep arc from 30 to 300 deg. Drive also provides a sweeping voltage, proportional to shaft angle, applied to CRO's horizontal deflection plates. ★"Type 1263-A Amplitude-regulating Power Supply" keeps oscillator output constant as frequency is swept.—*General Radio Co.*, 275 *Massachusetts Ave., Cambridge* 39, *Mass.*

For more information circle **396** on inquiry card.

Slotted-line Sweep-drive

New "Type 874-MD Slotted-line Motor Drive" can drive probe carriage of "Type 874-LBA Slotted Line" at

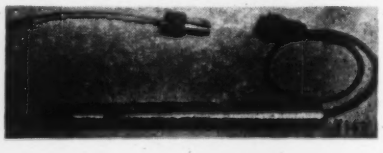


varying rates over distances from 1 to 47 cm.—*General Radio Co.*, 275 *Massachusetts Ave., Cambridge* 39, *Mass.*

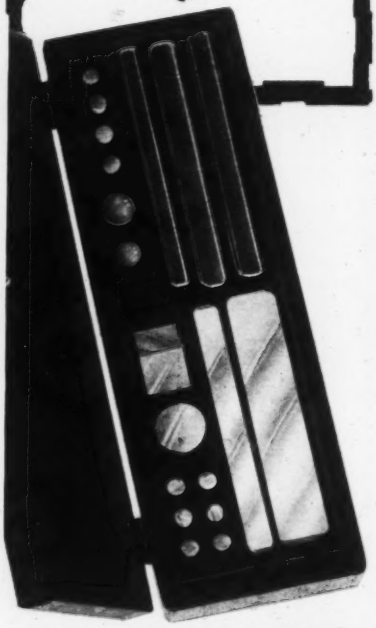
For more information circle **397** on inquiry card.

Traveling-wave-tube Amplifier

New X-band tube features broadband electronically tuned oscillations from 7 to 14 kMc, accomplished by single voltage without complementary



Now, an Engineer's Precision Optics Design Kit



HTL's OP-KIT

Houston Technical Laboratories offers engineers, chemists, and physicists an optics design kit from which to experiment and determine their exact optical requirements. The OP-KIT contains 19 selected optical components (see photograph).

A fitted pocket case (9⅜"x3"x1⅝"), the OP-KIT is a convenient and permanent *specimen library*. The part number, exact dimensions, and specifications of each component are printed in the box cover for ready reference. All optic samples shown are ready for immediate delivery in any quantity. And from HTL, you receive CUSTOM PRECISION at PRODUCTION PRICES!

price of OP-KIT complete **$49.50** ppd.

HTL is also your most dependable source for custom precision optics. Whatever your specialized requirements, they will be filled to the most exacting specifications and promptly. We welcome your inquiries.

ORDER YOUR OP-KIT TODAY

HTL HOUSTON TECHNICAL LABORATORIES

A Subsidiary of Texas Instruments Incorporated

2424 Branard • Houston 6, Texas, U.S.A.

For more information circle **129** on inquiry card.

mechanical adjustments; is suitable for swept signal generators for automatic testing, swept local oscillators, and wide-band transmitter-receiver applications. It can be swept across X-band in less than one microsecond. Characteristics: 300 to 3000 volts, 12 milliamps current, and 10 milliwatts output. X-band voltage requirements 450 to 2000.—*Huggins Labs., Inc., 711 Hamilton Ave., Menlo Park, Calif.*

For more information circle **398** on inquiry card.

H-f Transformers

New miniature power transformers for 400 cycles and higher frequencies are available with output power ratings up to 15 va with multiple windings from 1 to 500v; in miniature metal cases or plastic-encapsulated to satisfy MIL-T-27.—*Hycor Co., Inc., 11423 Vanowen St., N. Hollywood, Calif.*

For more information circle **399** on inquiry card.

Gain-standard Antennas

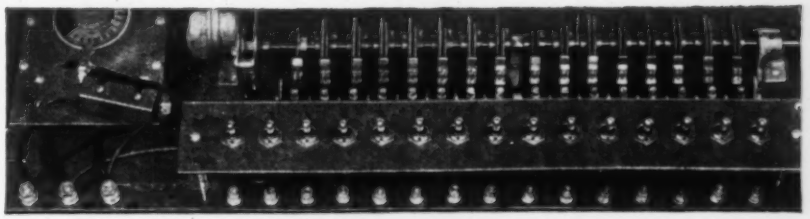
New parabolas (illustrated), horns, dipoles, and dipole arrays with precision gain calibration to 0.2 db, for

precise determination of propagation gain, cover spectrum from 100 Mc to 50,000 Mc.—*Color Television, Inc., 952 E. San Carlos Ave., San Carlos, Calif.*

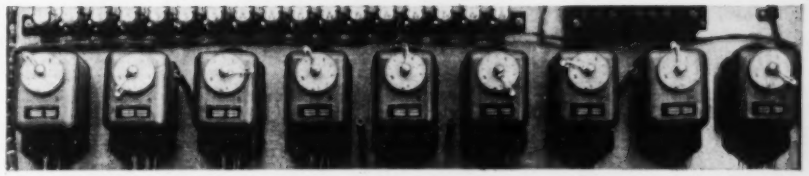
For more information circle **400** on inquiry card.

Portable Rotary Supply

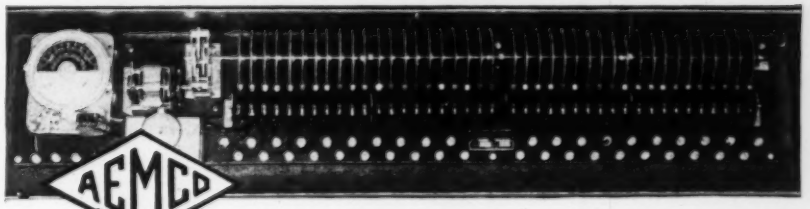
New "Carter-Pak" self-contained rotary power supply is desirable as "110 volts in a suitcase": 12-v aircraft storage battery, frequency-controlled dc to ac rotary converter, and battery charger which plugs into any ac outlet



switching . . .



to automatic control?



has a complete line of relays, timers and time switches to assist *you*

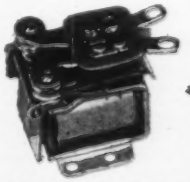
Specialists in the control field for more than 30 years, AEMCO engineering offers you fresh, new ideas . . . ideas that save you money in automatic control . . . ideas that save you valuable time. Yes, AEMCO is selling service as well as a complete line of relays and both automatic re-set and sequence timers.

AEMCO

RELAYS

At AEMCO we specialize in both the design and manufacture of relays to your mechanical and electrical specifications. Should one of hundreds of stock AEMCO relays fail to meet your specialized requirements exactly, we will design and build a unit not only to meet, but to exceed those specifications.

- Open or can types
- Miniatures and sub-miniatures
- Power Relays
- Delayed make or break types
- Circuit control relays
- Current and potential relays



For detailed information on the complete AEMCO relay line, write for your copy of Relay Catalog H.

AUTOMATIC RE-SET AND SEQUENCE TIMERS

Now control that vital operation . . . automatically! Available in many different models with automatic or manual reset, AEMCO industrial time controls help eliminate waste . . . help speed up production. Variations are available on standard cycling models . . . dials are easy to read, easy to set.

- AR and MAR—Automatically re-cycles at end of cycle
- ARD and MARD—Re-cycles with an interruption of current
- ARR—Repeating cycle
- MARA—Two circuits—both closed and open. Circuits completely adjustable
- No. 400—Sequence timer. Momentary start—automatic stop or continuous cycling. Any number of circuits.

For detailed information on AEMCO industrial time controls, write for your copy of AEMCO's Time Control Bulletin.

AEMCO

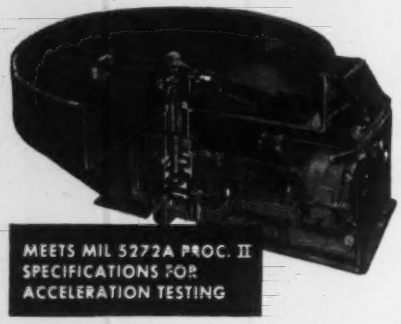
AUTOMATIC ELECTRIC MANUFACTURING CO.

54 STATE STREET • MANKATO, MINNESOTA

For more information circle **130** on inquiry card.

GENISCO MODEL B G-ACCELERATOR

A precision centrifuge for testing reliability of electronic components under simulated operational G-loadings



Simple operation—To operate, simply mount test object, connect slip rings and accessories, push "start" button and turn handwheel to desired r.p.m. Quick, easy operation makes the Model B particularly suited to large quantity test programs.

Extreme accuracy—The Vickers Hydraulic Transmission provides smooth, constant boom rotation over full r.p.m. range. Wow is less than 0.5% of set speed above 10 r.p.m. Drift at any set speed above 10 r.p.m. is less than 0.1% per minute.

R.P.M. easily measured—A tachometer and timer and counter for measuring rotation rates are standard equipment. A strobe unit which measures exact boom speed (within accuracy of line frequency) at 90 settings over the full r.p.m. range is available as optional equipment.

G-range of 0.017 to 120 G's—Boom rotation speed is infinitely variable from 5 to 420 r.p.m. Radius of gyration ranges from 19" to 24".

Rugged construction—Heavy cast-and-fabricated structure and adequate safety factors assure maximum operator safety, long life, minimum maintenance.

Now four Genisco G-Accelerators!

MODEL NUMBER	G-RANGE	CAPACITY	RADIUS OF GYRATION
B78	0.017 to 120	25 lbs.—8" cube	24"
C159	0.024 to 75	100 lbs.—24" cube	44"
D184	1 to 800	6 1-lb. objects	12"
E185	0.01 to 60	300 lbs.—30" cube	72"

Optional equipment... additional internal and overhead sliprings, air system, optical system, and other accessories are available for Genisco G-Accelerators. Write to Genisco, Inc., 2233 Federal Avenue, Los Angeles 64, California, for detailed specifications.

RELIABILITY FIRST

Genisco INCORPORATED

For more information circle **131** on inquiry card.

to replenish battery when required.—*Carter Motor Co., 2644-A N. Maplewood Ave., Chicago 47, Ill.*

For more information circle **401** on inquiry card.

Regulated Power Supplies

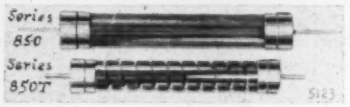
Four new basic designs in maker's "Laboratory Grade" line of 32 models have been modified to meet MIL-E-4158A (USAF) so that equipment designers, who are furnishing ground-base equipment to meet this new MIL-SPEC, can obtain stock power supplies for any fixed output voltage (adjustable ± 25 volts) from 0 to 1200 volts in three standard current ranges: 300, 600, or 1200 ma maximum. Regulation 0.25% line or load; standard ripple 4 mv rms.—*NJE Corp., 345 Carnegie Ave., Kenilworth, N. J.*

For more information circle **402** on inquiry card.

ELECTRICAL and ELECTRONIC COMPONENTS

Film-type Resistors

New "Series 850" metal film resistors feature increased maximum values (1.2, 2.2 and 3.0 megohms for ½-, 1- and 2-watt ratings); also extremely



low reactive component of impedance. ★ New high-temperature "Series 850T" can be used at 150°C (302°F) at full rated power; feature temperature coefficient below 400 ppm/°C, unique for film-type units.—*The Daven Co., 191 Central Ave., Newark 4, N. J.*

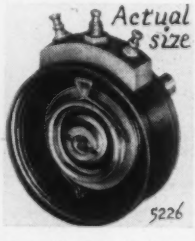
For more information circle **403** on inquiry card.

Trimming VDRs

New "Acetrim" subminiature precision wire-wound voltage-dividing resistors, for use as trimmers, can operate in ambient temperatures between −55°C and 125°C; are available in resistance values from 10 to 50,000 ohms; feature a new shaft lock. All units are completely sealed against sand, dust, etc., are moisture-proofed and fungicide treated, meet MIL and JAN specs.—*Ace Electronic Associates, 125 Rogers Ave., Somerville 44, Mass.*

For more information circle **404** on inquiry card.

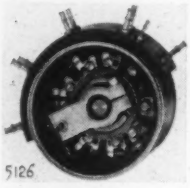
Subminiature VDRs



New "Series C-078" voltage-dividing resistors weighing ½ oz. and with ⅞-in. diameter have many features of full size units, including multiple-finger contact brushes, gold connectors, and 320° electrical rotation, housings completely enclosed. Units can be ganged and independently phased. Also available with special torque ratings, ball-bearings, special tolerances and other requirements for any linear or non-linear function.—*DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.*

For more information circle **405** on inquiry card.

Ball-bearing VDRs

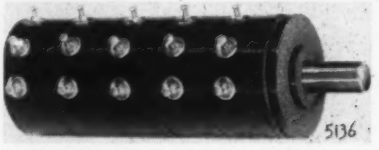


New 2-in high-precision "Series BC-200" units feature lower starting and running torque than preceding series, also minimized radial shaft play and backlash between ganged sections, whence more accurate solutions of mathematical equations. Average starting torques do not exceed 0.5 oz-in per unit.—*DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.*

For more information circle **406** on inquiry card.

Rotation-type VDRs

New "S 1-5000 Series" single-turn voltage-dividing resistors comprises nine models, wide range of specifications, ½-in to 3-in diameters. One-inch



continuous mechanical rotation units are gangable as shown; electrical rotation, 352 ± 5 deg; resistance values 5 ohm to 50 K; standard resistance tolerance 5%; standard linearity tolerance 2%; power rating 1½ watt.—*General Scientific Corp., 12027 Vose St., N. Hollywood, Calif.*

For more information circle **407** on inquiry card.

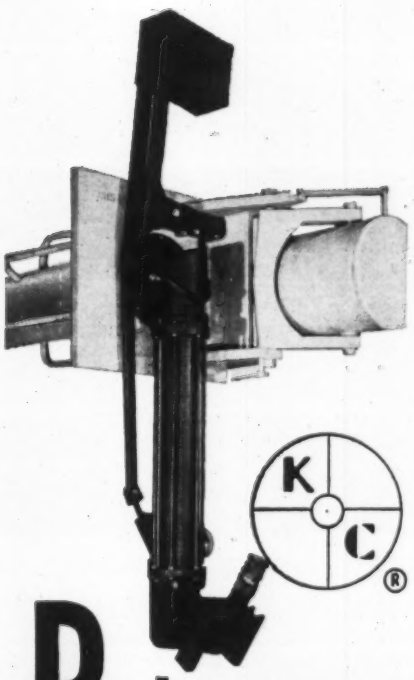
Transistorized Flip-flop

New "Type 200 C5" encapsulated plug-in transistorized clamped flip-flop with unusually low power and space requirements is suitable as a subminiature plug-in binary element for computer applications; is said to use "an entirely new concept of printed circuit design." It is a bistable circuit including two junction transistors, two input diodes, and four clamping diodes, measuring 1⅝ x 15/16 in. and with a standard 7-pin miniature tube-type plug-in base.—*Sprague Electric Co., 343 Marshall St., North Adams, Mass.*

For more information circle **408** on inquiry card.

Pulse Transformers

New line of miniature pulse transformers comprises two distinct types: (1) a series of metal case designs with approved type glass seal ter-



Periscopes

For "HOT SPOT" Remote Observation

A custom designed industrial periscope is very often the answer to "Hot Spot" remote control handling, instrumentation and observation. We have designed and manufactured many such periscopes.

If you have a problem calling for a periscope or for any precision optical system, check with us. For nearly half a century Kollmorgen has designed, developed and manufactured precision optical products including Industrial and Naval Periscopes, Fire Control Devices, Projection Lenses and Navigational Instruments for Industry and for the Armed Services.

Send for Bulletin 301

KOLLMORGEN Optical CORPORATION

Plant: 347 King Street, Northampton, Mass.

New York Office:

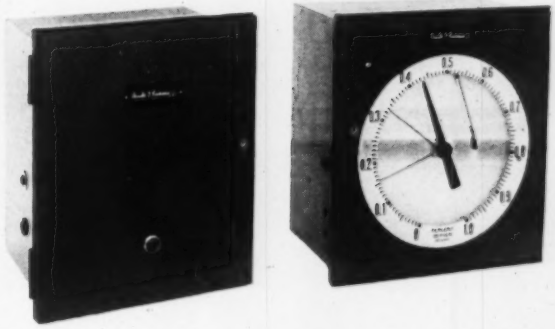
30 Church Street, New York 7, New York

For more information circle **132** on inquiry card.

NEW SAVINGS in your operations

with

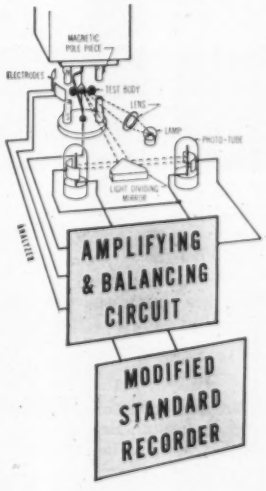
Arnold O. Beckman OXYGEN ANALYZERS



Pictured is the Model G2 Recording Analyzer—finest for precise oxygen measurement.

ON OPERATIONS LIKE THESE... MAKE SAVINGS LIKE THESE

PROCESSING AIR LIQUIFRACTION AND PRODUCTION OF HIGH PURITY GASES	*Better product quality with minimum oxygen or air contamination*
SAFETY PRODUCTION OF HYDROGEN, ACETYLENE, ETC.	*Control explosive atmospheres, reduce fire risks, minimize plant and personnel hazards*
PRODUCT PROTECTION RESIN KETTLES, COLOR PIGMENTS, PRODUCT STORAGE, ETC.	*Reduce oxidation, maintain product standards with controlled purge systems*



Unique Operating Principle

The various applications highlighted above are only a few of the many ways Arnold O. Beckman Oxygen Analyzers—industry's great new profit builders—are being used by progressive operators to boost profits, cut costs.

These are the *only* oxygen analyzers that *continuously* measure process streams by an advanced magnetic principle that provides *direct physical measurement of the oxygen itself*—not of some secondary relationship.

Heart of the unit, as illustrated, is a dumbbell-shaped test body suspended in a magnetic field. Sample gas surrounding this test body causes it to rotate in the field, depending upon the oxygen content of the gas. The movement of a light beam, reflected by a small mirror on the test body, is measured by simple electronic circuits... and the result indicated directly on a conventional recorder or indicator. It's simple, positive, accurate!

No chemicals—filaments—catalysts cams—complicated mechanical parts!

FEATURES OF THE G2

Many ranges: Full scale ranges 0-0.1%, 0-0.5%, 0-1% O_2 and others for low O_2 concentrations. Ranges 90-100%, 95-100% O_2, etc., for high O_2 concentrations.

Multi-Ranges: Any instrument may be supplied with two or more ranges.

Note: For ranges wider than 0-5% O_2, ask about the Model F3 Analyzer.

***Send for Helpful Free Literature** which describes this unique operating principle in detail—explains its many advantages and applications. When writing, outline your particular operations—we'll gladly supply specific information.*

Ask For Data File 15G-85

Arnold O. Beckman INC

Instruments for Science and Industry

1020 MISSION STREET

SOUTH PASADENA, CALIFORNIA

See Our Booths #419-420 at the September ISA Show.

For more information circle **133** on inquiry card.

Stepless temperature Control

NOW! TUBELESS, MULTI-LOAD

Improved Model JS Series GARDSMAN Stepless Controllers by WEST. One Instrument Handles a Range of Wattage Requirements.

★ **Closest Control**
★ **Save power**
★ **Prolong Heater Life**
★ **Adjustable Band**
★ **Manual Reset**
★ **Simplest Operation—One Knob**
★ **Least Maintenance**

See us in L.A.—Booths #B448-B449

Without tubes or relays, this unique instrument *modulates* input to suit demand. Proved in wide use. Write for Bulletin JS.

4355 W. Montrose Ave.
Chicago 41, Illinois

WEST Instrument CORPORATION
CHICAGO
SALES OFFICES IN PRINCIPAL CITIES

For more information circle **134** on inquiry card.

ANALOG COMPUTER ENGINEERS

Bendix Research Laboratories Division, the center of advanced development activities for the Bendix Aviation Corporation is offering excellent opportunities for competent analog computer engineers. Problems in the fields of missile guidance systems, navigation studies, nuclear reactor controls, hydraulic control devices and other related projects.

The Research Laboratories is a small, separate division of a well-established reputable engineering organization, exclusively devoted to research and development of a wide variety of interesting, progressive and highly imaginative projects. Opportunity for graduate study.

SENIOR ANALOG COMPUTER PROBLEM ANALYST

5 - 7 years experience in dynamic analysis utilizing analog computers, must be able to direct problem from origin through computer set-up and operation, and include final analysis. Advanced degree desirable with good mathematical or physics background.

SENIOR COMPUTER PROBLEM ENGINEER

To assume responsibility for problem operation of an afternoon shift (4:00 PM - 12:45). 4 - 5 years of experience in computer operation. Responsible for problem set-up, checkout, operation and evaluation. Degree in math or physics.

ANALOG COMPUTER PROBLEM ENGINEER

3 - 4 years experience in computer operations and problems set-up. Degree in math, physics or EE necessary.

Send resume to: Personnel Department
Bendix Aviation Corporation
Research Laboratories Division
4855 Fourth Avenue
Detroit 1, Michigan

NEW INSTRUMENTS

minal header plates; (2) encapsulated in molded epoxy resin with several types of terminal connections. Six designs available from stock in 19 sizes with 21 ratios in each category.—*Acme Electric Corp., Los Angeles, Calif.*

For more information circle **409** on inquiry card.

Subminiature Photocell

New "Type 6694" tiny cadmium-sulfide photoconductive cell of head-on type features high luminous sensitivity; extremely low dark current and background noise; output directly proportional to incident light intensity; characteristics not substantially affected by wide change in operating temperature; and spectral response covering visible range from about 0.35 micron to about 0.55 micron with peak at about 0.50 micron.—*Radio Corp. of America, Tube Div., Harrison, N. J.*

For more information circle **410** on inquiry card.

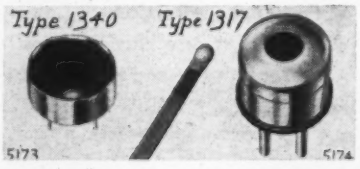
Industrial Phototube

New "65700" vacuum phototube with non-hygroscopic base is suitable for industrial applications such as beverage-inspection; has a low order of microphonics; features sensitivity in red and near-infrared, whence suitability for use with an incandescent light source. Average luminous sensitivity 30 microamps per lumen.—*Radio Corp. of America, Tube Div., Harrison, N. J.*

For more information circle **411** on inquiry card.

Far-infrared Pickups

New "Type 1340 Servotherm Thermistor Heat Detector Cell" is designed specifically for far-infrared laboratory applications plagued by internal "swish" noise from air set in motion by high ambient vibrations; features an evacuated capsule made by joining a coated silver chloride window to a silver housing; contains both active and compensating flakes. Cell performance varies according to flake

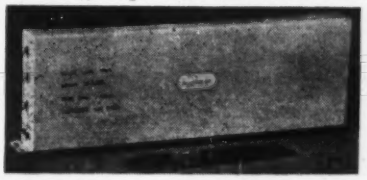


size. Six standard flake sizes; others on special order. Characteristic time is 2.5 milliseconds; sensitivity 250 volts/watt. ★New "Type 1317 Servotherm Thermistor Heat Detector Cell," low-cost unit for commercial applications, contains both active and compensating flakes. Six standard flake sizes; others special.—*Servo Corporation of America, 2020 Jericho Turnpike, New Hyde Park, N. Y.*

For more information circle **412** on inquiry card.

20-usec Delay Line

New "XN-1" lumped parameter 20-microsecond delay line has a rise time of 1 usec; impedance 600 ohms. Unit

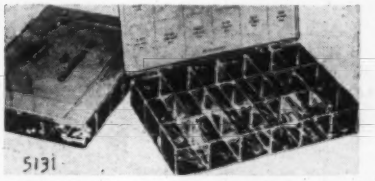


is hermetically sealed in Epoxy resin; operates through temperature range from –70°C to 135°C.—*The Gudeman Company of California, Inc., 2661 South Myrtle Avenue, Monrovia, California.*

For more information circle **413** on inquiry card.

Capacitor Kits

Two new "Ceramicon Kits" for servicemen and engineers consist each of an 18-section plastic storage case

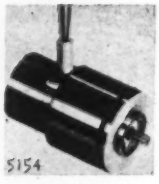


containing 100 high stability disc "Ceramicons" or 100 "GP Tubular Ceramicons" in 18 popular values.—*Erie Resistor Corp., Erie, Pa.*

For more information circle **414** on inquiry card.

ELECTROMECHANICAL COMPONENTS

Brake-servomotor Unit



New "Type 2V-2397" instant-stopping brake-servomotor unit, guaranteed for 100 hours' operation at 125°C, is said to respond instantly to excitation at –65°C. No preliminary warm-up needed at low temperatures. Theoretical acceleration is 12,000 rad/sec² and stopping time 0.02 sec with no external inertia loading. Unit weighs 2.56 oz.—*John Oster Mfg. Co., Avionic Div., 1 Main St., Racine, Wis.*

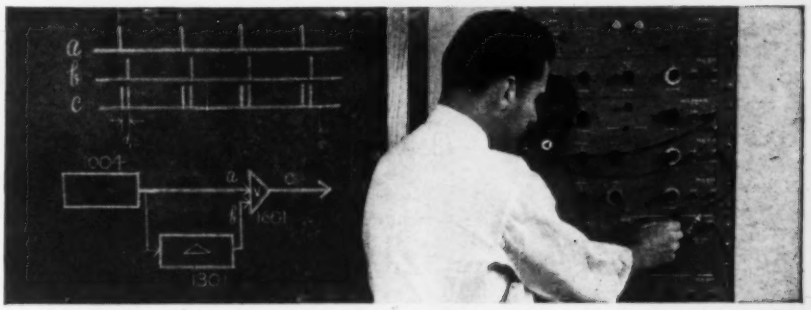
For more information circle **415** on inquiry card.

Magnetic Clutch

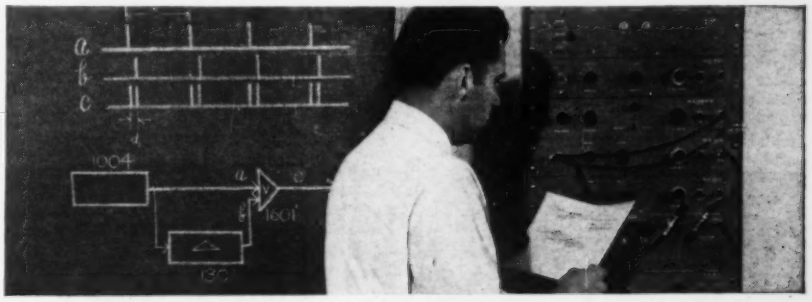
New "Model T508 Triplex Magnetic Clutch" is designed for servo system applications requiring possibility of engagement or disengagement of eith-

er one or both output shafts from a single input shaft. This is accomplished by enclosing two magnetic coils and two sets of couplings in one housing. Functions of shafts can be

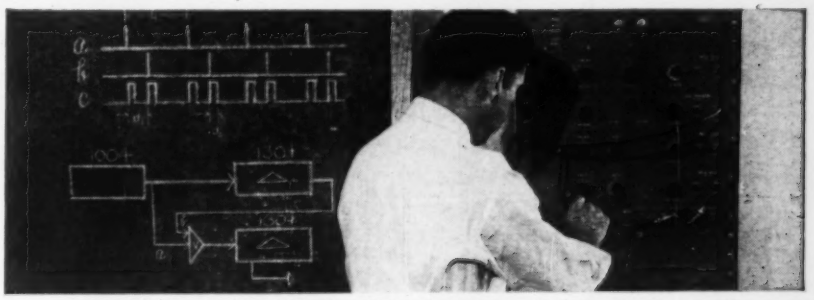
Engineer using BURROUGHS PULSE UNITS loses no time designing test equipment



1. **FAST SET-UP.** Engineer draws pulse sequence, then determines by block diagram how to connect his Burroughs Pulse Units. Usually this can be done in a matter of minutes.



2. **JOB COMPLETED.** No time lost. Because engineer spends no time designing test equipment, he can spend his full time on the real problem. This means he can do more, accomplish more.



3. **NEXT ASSIGNMENT.** Without losing time, engineer simply determines the block diagram needed to produce the next pulse sequence and sets up his Burroughs Pulse Units. He shifts quickly from one assignment to the next—saving considerable time otherwise needed to design and build special test equipment.

GET THE FACTS

Learn how you can make your time worth more. Burroughs Pulse Units save weeks of engineering, uncertainty, and considerable equipment cost. Can be used over and over again on different future projects. Immediate delivery from stock. Write for detailed brochure. *Burroughs Corporation, Electronic Instruments Division, Dept. 5-H, 1209 Vine St., Phila. 7, Pa.*

ELECTRONIC INSTRUMENTS DIVISION

Burroughs

FIRST IN PULSE HANDLING EQUIPMENT

For more information circle **136** on inquiry card.

DURING THE DESIGN PERIOD TOO !

the most experienced men in their field can help you . . .

Production problems are best resolved in the designing stage. That is why we recommend consulting us during the design period.

when designing your

EDGE-LIGHTED PANELS and **DIALS**

. . . our engineers and consultants can save time for your design department and assure the optimum in lighting uniformity, appearance, ruggedness, and simplicity.

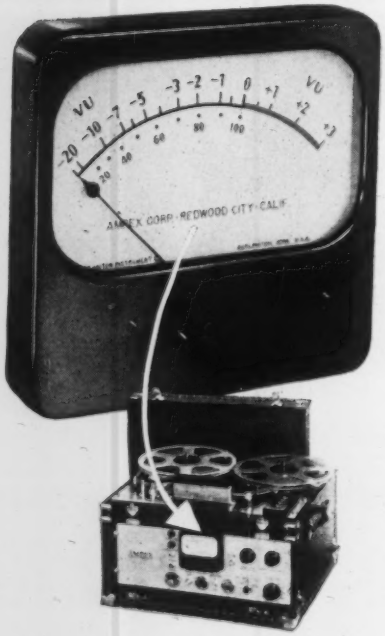
Edge-lighted panels and dials for Specification MIL-P-7788, produced by the "Lackon Process" and backed by years of experience in the lighting field, are your assurance of the ultimate in appearance and functional characteristics.

For worthwhile information on edge-lighting, address Dept. IA-8.

UNITED STATES RADIUM CORPORATION

Eastern Sales Office — 535 Pearl St., New York 7, N. Y.
Western Sales Office — 5420 Vineland Ave., N. Hollywood, Calif.
Plants and Laboratories at: Bloomsburg, Pa., Whippany, N. J. Bernardsville, N. J., North Hollywood, Calif.

For more information circle **137** on inquiry card.



Try this on your recorder!

Model 745
4½" Semi-Flash

Famous names choose Burlington for consistent quality and prompt service. Burlington offers the widest range of VU meters—from 1½" to 4½" in a variety of case materials and styles including bakelite, metal, hermetically sealed and sealed ruggedized. Square, Round, Rectangular and Fan-shaped. Standard meters of every description. "If you don't see it—ask for it"—

WRITE FOR CATALOGUE N1
Shows cases, ranges, prices

BURLINGTON INSTRUMENT COMPANY
131 N. Third St., Burlington, Iowa

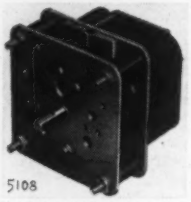
Burlington
CUSTOM BUILT TO SPECIFICATION

For more information circle **138** on inquiry card.

reversed so that outputs can be used as inputs to permit selection of either of two input rotations to be transmitted to a single output shaft.— *Sterling Precision Instrument Corp., 34-17 Lawrence St., Flushing 54, N. Y.*

For more information circle **416** on inquiry card.

Instrumentation Motors

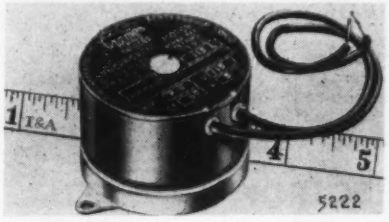


New open type geared motor designed for overhanging or radial thrust loads are available in synchronous or non-synchronous unidirectional, or non-synchronous reversible types; starting torques up to 75 lb-in. and gear ratios from 4:1 to 30,000:1. For recording instruments, timers, office machines, etc.— *Small Motors Div., Barber-Colman Co., Rockford, Ill.*

For more information circle **417** on inquiry card.

Synchronous Timing Motor

New "Type 113," designed for high-volume applications such as appliance timers, etc., runs equally well in any

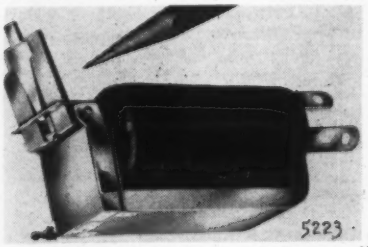


position, weighs less than 6 oz; has torque rating of 30 oz-in at 1 rpm (2, 4 and 8 rpm also available). Right, left or oscillating shaft rotation available. Other features include start-stop within 2 cycles, truly synchronous operation, temperature rise 43°C. Minimum ordering quantity 1000 units.— *R. W. Cramer Co., Inc., Centerbrook, Conn.*

For more information circle **418** on inquiry card.

Solenoid Actuator

New "Model L 22 A" light-weight (50-gram) electromagnetic solenoid actuator features unique linkage sys-

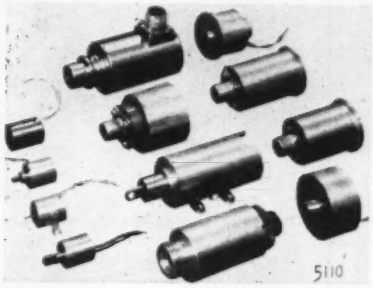


tem available in either a push or pull arrangement, which magnifies original air-gap movement eightfold; operates on 1.8 watts, within 7 milliseconds at normal voltage; Specs: 1260 ohms, 7400 turns, 48 v dc, 0.038 amp, 1.8 watt; stroke 0.125 max.; pull 100 to 550 grams. Other coils for special voltages are also manufactured.— *James Cunningham, Son & Co., Inc., Rochester 8, N. Y.*

For more information circle **419** on inquiry card.

D-c Solenoids

New line of stock and custom-designed dc solenoids includes sub-miniatures, high-temperature and pressurized units, manufactured to MIL-

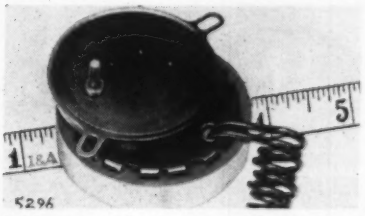


S-4040 for automatic controls, computers, etc.; featuring pressure-balanced armatures, adjustable stroke under operating pressure, maximal efficiency in minimal size, hydraulic pressure sealed and hi-temp coils.—*Braunson Electronics, Inc.*, 411 *Rose Ave., Venice, Calif.*

For more information circle **420** on inquiry card.

Synchronous Timing Motor

New 60-cps synchronous timing motor features thin construction, quiet operation (in any position), no lub-

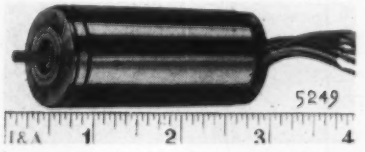


rication required, can be stalled continuously, accessible mounting lugs, and UL approval. It is accompanied by a one-year guarantee. Applications include household circuit programming controls, recording equipment, time delay switches, etc. Many possible combinations of parts from standard stock.—*United States Time Corp., Waterbury* 20, *Conn.*

For more information circle **421** on inquiry card.

Motor-generator

New Size 11 motor-generator comprises maker's standard Size 11 "Precision Servo Motor" and a drag cup



generator. Motor is normally designed for operation on 115-v 400-cps, no-load speed 5200 rpm. Generator is normally wound for 115-v 400-cps excitation; output voltage 0.5 per thousand rpm. —*G-M Laboratories, Inc.*, 4300 *No. Knox Ave., Chicago* 41, *Ill.*

For more information circle **422** on inquiry card.

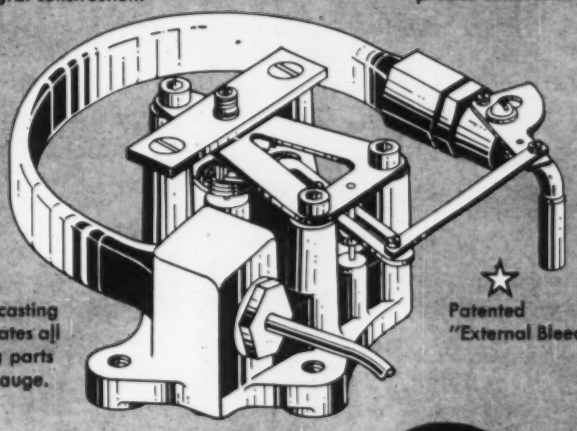
Tachometer Feedback Unit

New miniature combination servomotor and a-c tachometer generator that operates on 60 cycles has zero backlash, can be used to regulate mo-

HEISE GAUGES

Permanent positive accuracy of alignment guaranteed by integral construction.

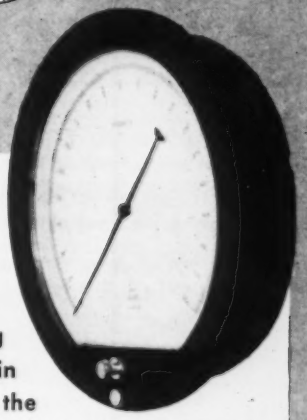
Weldless heat treated Bourdon tube maintains precise calibration.



Massive Bronze casting coordinates all working parts of the gauge.

Patented "External Bleeder"

Dial individually engraved with reference to the pressure gradient of its gauge mechanism.



ACCURACY

The standard of excellence maintained by Heise qualifies this instrument for the most exacting requirements. Designed to maintain permanently its inherent precision, the Heise gauge is often used in place of the dead weight tester in checking other instruments. Consistently accurate performance as a calibration reference has established its recognition as THE STANDARD OF THE WORLD.

SPECIALIZATION AND EFFICIENCY

Heise Laboratories have always specialized in the design and production of high precision pressure gauges. The highest standards of quality control protect the manufacture and assembly of each component and the permanent calibration of the finished instrument.

Efficiency in the production of one type instrument, precision pressure gauges, has made it possible to maintain a prompt delivery schedule.

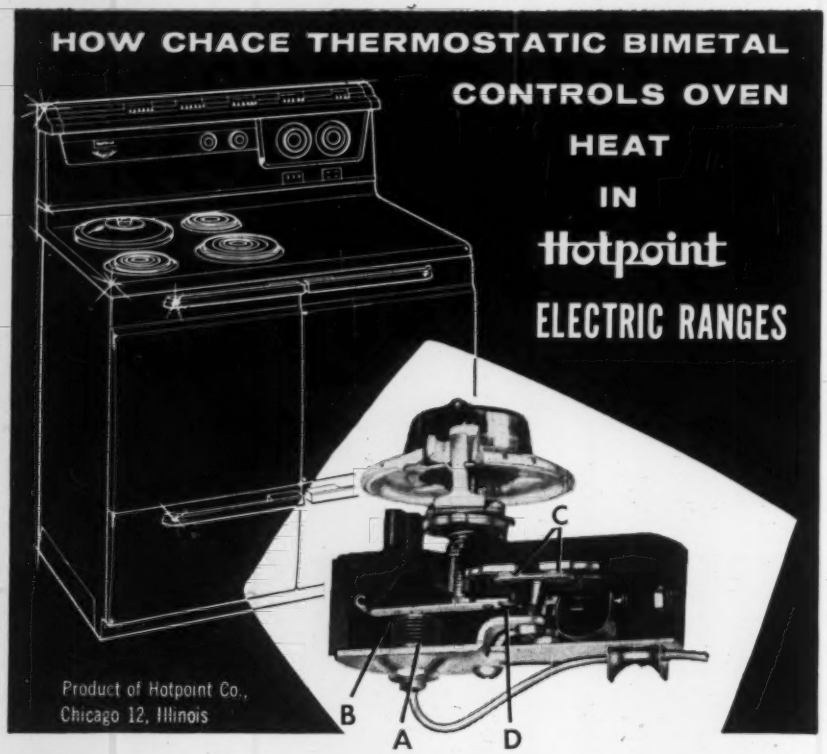
DELIVERY WITHIN 30 DAYS.

Pressure Range 15 to 20,000 P.S.I.
Dial Sizes 8½"—12"—16"
Prices from $151.60

Catalog on Request

HEISE BOURDON TUBE COMPANY, INC.
BROOK ROAD, NEWTOWN, CONNECTICUT, U.S.A.

For more information circle **139** on inquiry card.



During the last fifty years, the Hotpoint Company has pioneered in the development of the electric range to its present highly refined state. Naturally, dependable regulation of oven temperatures is essential to efficient operation. Therefore, the Hotpoint range depends upon Chace Thermostatic Bimetal as an integral part of the temperature controlling thermostat.

The Hotpoint thermostat functions to control oven heat by two means: an oven-mounted sensing bulb reacts to a preset temperature by the expansion of contained fluids which impart a force on the expansible and contractible bellows assembly (A), and on the operating blade (B), to break the circuit of the double pole contacts (C), with a snap-action.

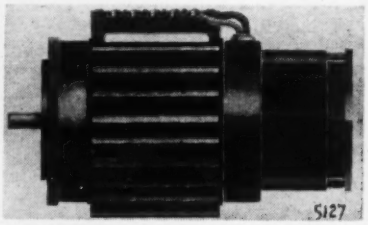
Since much of the fluid contained within the bellows assembly is *exterior* to the oven and subject to the expansion and contraction effects of extraneous temperatures, Chace Thermostatic Bimetal (D) is employed in a section of the operating blade to function as an automatic compensator for eliminating the effects of undesired temperature sensing. Its flexing adds to or subtracts from the forces of curvature of the operating blade depending upon whether the temperature is below or above the design base—average room temperature.

Prolonged oven operation will cause a temperature build-up in the range backsplasher (as high as 200° F.) so that the range, if not provided with a compensating Chace Thermostatic Bimetal element, would supply temperatures some 120° F. lower than desired.

Write now for our free booklet containing design and application data for the 29 different types of Chace Thermostatic Bimetal.

For more information circle **140** on inquiry card.

NEW INSTRUMENTS

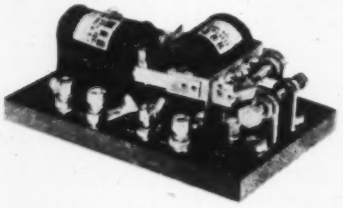


tor speed, to stabilize closed-loop circuits, etc. New design permits ready adjustment after installation, so that in-phase residual voltage of tachometer is essentially zero. Available: high-impedance control phase windings for plate-to-plate operation; 57½/57½ volt control-phase windings for magnetic amplifier applications; motor ratings of 1, 5 or 10 watts output; five gear reduction ratios.—*Diehl Mfg. Co., Finderne Plant, Somerville, N. J.*

For more information circle **423** on inquiry card.

Double-function Relay

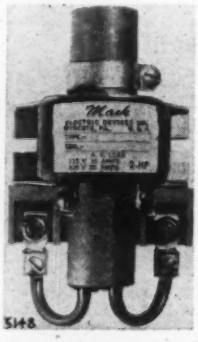
New "Series 22L" impulse-latching, mechanical-locking and electrical-impulse-reset relay, said to be "highly



useful for applications where it is not practical to have the holding coil in constant service," consists of two sensitive relays (ac or dc or combination) with contacts rated at 2 amp. 110 vac, spdt or dpdt. Optional features: tropicalization, varnish impregnated coils, etc.—*Kurman Electric Co., 35-18 37th St., Long Island City, N. Y.*

For more information circle **424** on inquiry card.

Mercury-plunger Relay



New mercury plunger relay will not break during shipping, installation or use; has a protective fiber cylinder; is said to combine efficiency of glass with ruggedness of metal. No exposed arc: mercury displaced by plunger makes and breaks circuit in inert gas. Relay takes 60 milliseconds to close, 40 to open. Wide range of coil voltages, and contacts handle motor loads up to 2 hp.—*Mack Electric Devices, Inc., Wyncote, Pa.*

For more information circle **425** on inquiry card.

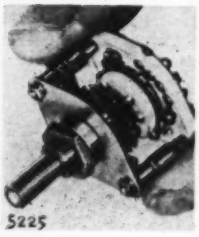
Aircraft Circuit Breaker

New miniature trip-free "Klixon D6761 Aircraft Circuit Breaker" is exceptionally small in size for its rating: two units fit into same mounting space as one "MS" breaker. It has

conventional button action; has successfully handled over 2000 amps 120 vac 400 cps; meets MIL-C-5809; is available in ratings from 5 to 35 amps.—*Spencer Thermostat Div., Metals & Controls Corp., Attleboro, Mass.*

For more information circle **426** on inquiry card.

Miniature Ceramic Rotary Switch

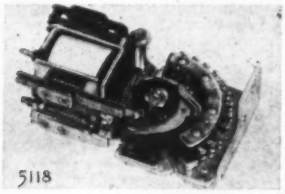

5225

New "Series M" occupies a panel area of less than 1½ sq in; is designed to perform in all severe types of field service; features coin silver contacts, rotors and slip rings, silicone-impregnated ceramic parts, etc. Single-pole style has 18 shorting type contact positions available in many combinations. Several sections can be ganged; 2 or 3 poles per deck can also be obtained. Flash-over voltage at 60 cps 1000; capacity 2 amps.—*The Daven Company, 191 Central Ave., Newark, N. J.*

For more information circle **427** on inquiry card.

Stepping Switch

New "Type 11 Springdriven Stepping Switch" is latest in maker's line of uniselectors, or rotary switches, for completing, interrupting or


5118

changing connections in a succession of electric circuits in response to momentary impulses of current, in such applications as (1) selecting any desired point in a series, (2) selecting first unoccupied point in a series, (3) sequence controlling, (4) counting and totalizing, (5) generating timed impulses, and (6) monitoring.—*C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Ill.*

For more information circle **428** on inquiry card.

Insulator Terminals

New stand-off and feed-through insulator terminals incorporate Teflon, for use in high and ultra-high frequency applications. Resiliency of Teflon allows permanent 10 lb. minimum pull test press-fit installation, eliminating mounting hardware. Teflon's dielectric constant (2.0) and loss factor (0.005) are unaffected in temperatures from 80° F. to 400° F.—*Tri-Point Mfg. & Developing Co., Inc., 401 Grand St., Brooklyn 11, N. Y.*

For more information circle **429** on inquiry card.

Connectors for Graphic Circuits

Five new connectors meet requirements of miniaturization; have 10, 18, 22, 28 and 44 contacts; are made of

EAD's 2" DIAMETER MOTOR
Makes Design easy as 1-2-3-

1. one basic design
2. only 2" in diameter
3. three frequencies...60, 400 and variable

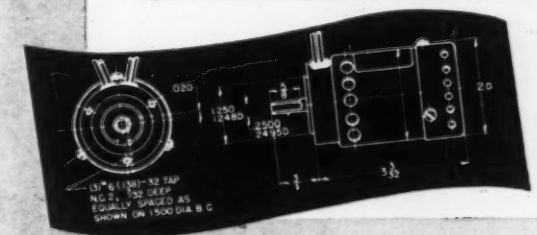
Here is one basic motor design incorporating the top-quality engineering that's "standard" at EAD . . . and capable of modifications for an unusually broad field of applications. You can order this 2" diameter motor (maximum weight is only 17 ounces) as an induction motor or a hysteresis-synchronous motor. It meets applicable MIL specifications and is available with Class "H" insulation for long life, high temperature operation. Just one more example of how EAD engineering meets the most exacting requirements for rotating electrical equipment.

INDUCTION MOTOR: For blowers, fans, automatic devices, business machines, control equipment, antenna drives, etc.

	HP	RPM	AMPS	MODEL
60 cycle, 115 volts	1/100	3,000	0.30	P52QDU
400 cycle 115 volts	1/100	7,200	0.30	P52QFU
	1/50	7,000	0.40	P52NFU
	1/30	6,200	0.80	P52LFU
	1/50	22,000	0.75	P50NDU
320-1200 cycle variable frequency	1/300	4,500 av.	0.60	P52UFU
	1/50	4,000	0.80	P52NEU

HYSTERESIS-SYNCHRONOUS: For timing devices; stroboscopic work; wherever load inertia is a problem (i.e. recorders, turntables, facsimile equipment, etc.)

	HP	RPM	AMPS	MODEL
60 cycle, 115 volts	1/200	3,600	0.26	P52SRU



Complete information on EAD's line of small motors and engineering - design service will be sent on request.

EASTERN AIR DEVICES, INC.

SOLVING SPECIAL PROBLEMS IS ROUTINE AT EAD

INDUCTION MOTORS · CENTRIFUGAL BLOWERS · TACHOMETER GENERATORS · FANS · ALTERNATORS · GEAR MOTORS

347 CENTRAL AVENUE • DOVER, NEW HAMPSHIRE

For more information circle **141** on inquiry card.

SOLVED

weighing and testing problems by

EMERY force-measuring systems

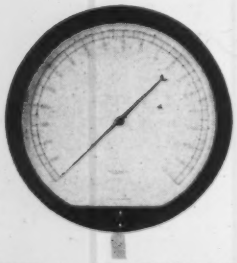
Emery load cells offer the fundamental solution to *any* force-measuring or weighing problem.

Operating on simple, basic physical principles, Emery systems are maintenance-free. Some units have been in service over 25 years without even recalibration!

RANGES: 0 - 10,000,000 pounds . . . **ACCURACY:** 1/10 of 1% of range . . . **RESPONSE:** less than ½ second . . . **TYPES:** self-contained hydraulic, open-flow hydraulic, pneumatic . . . **CELL DEFLECTION:** less than 0.005" . . . **APPLICATIONS:** Weighing, Jet Engine Thrust, Brake Testing, Torque Measurements, Strength of Materials, Process Control, Tank Weighing, Platform Scales, Etc.

Since 1872, Emery Force-Measurement Systems have been lowest in initial cost, in operating cost, and require no maintenance.

Write today for information on stock or specially designed systems to solve your force-measuring problems.



THE A. H. EMERY COMPANY, NEW CANAAN 3, CONN.

Please send me
☐ Literature on hydraulic weighing
☐ Literature on pneumatic weighing
NAME _____
POSITION _____
Attach to, or write on, your company letterhead.

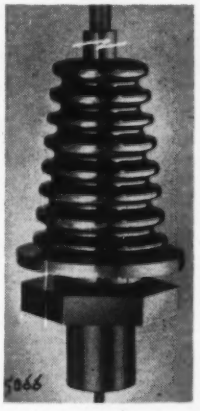
For more information circle **142** on inquiry card.

NEW INSTRUMENTS

Dupont Zytel molded insulation, with gold-plated phosphor-bronze or beryllium-copper contacts. Flashovers are 2000 v and 2500 v 60 cps ac (rms); current rating 5 amps. Polarization is accomplished by deleting one or more contacts and inserting a blanking stud in vacant cavity. Four connector types have single-contact rows, one double-contact rows. Rivet-and-eyelet type terminals are available.—*Cannon Electric Co., 3207 Humboldt St., Los Angeles 31, Calif.*

For more information circle **430** on inquiry card.

High-voltage Bushings



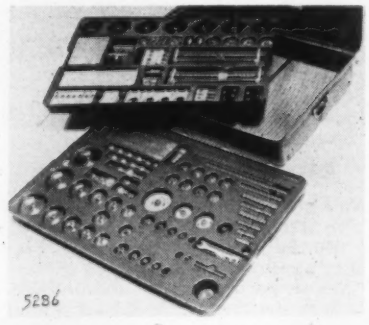
New "HVD" series of bushings feature connection between high-voltage source and output lead wholly concealed deep within unit, corona completely eliminated and maximal safety for operator. Units are molded of a tough flexible resin with high impact and dielectric strength; copper sleeve at contact curtails bombardment breakdown. "HVD-60" (60 kv) and "HVD-100" (100 kv) handle 1.5 kw; other assemblies higher wattages.—*Microtime Labs., 7247 Atoll Ave., North Hollywood, Calif.*

For more information circle **431** on inquiry card.

MECHANICAL COMPONENTS

Servo Components Kit

New "MechaKit," for electromechanical development and control simulation, comprises of an assortment of

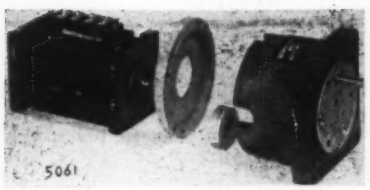


mechanical development apparatus, said to "answer the ever-increasing demands for a complete and available selection of precision laboratory equipment." Available in three sizes.—*Servomechanisms, Inc., Components Div., 625 Main Street, Westbury, N. Y.*

For more information circle **432** on inquiry card.

Gear Adapter Kits

New adapter kits are for coupling maker's precision gear boxes to many widely-used servomotors. Series com-

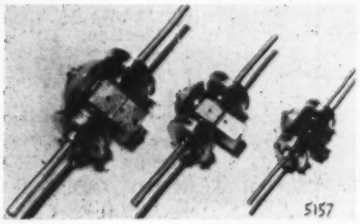


prises six kits for direct, in-line mounting to various type servomotors, and a special adapter kit for coupling gear box to a flexible shaft. Each kit contains an anodized aluminum adapter plate and coupling disc and all necessary attaching parts.—*Link Aviation, Inc., Binghampton, N. Y.*

For more information circle **433** on inquiry card.

Differentials and Gears

New differentials, for use as high-precision calculating mechanisms, combine two rotating inputs into one rotating output that is algebraic av-

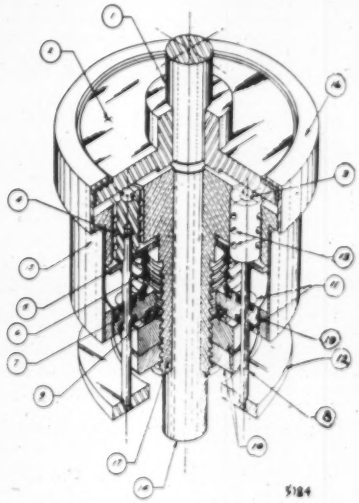


erage inputs. ★Unique differential end spur gears, machined to precision AGMA 1 tolerances, are clamped by a retaining ring to allow assembly and disassembly as required to suit change in design and material or re-use in other equipment. Adjustable counter-balance on center spider to assure smooth uniform running. Differentials and gears are available from stock, in various pitches, pressure angles, teeth, with 1/8, 3/16 and 1/4 in. shaft sizes. —*PIC Design Corp.*, 160 *Atlantic Ave., Lynbrook, L.I., N.Y.*

For more information circle **434** on inquiry card.

Torque Coupling

New "Torque Limiting Coupling" controls maximum torque transmitted from a driver to a driven element. Up



to adjustable limit, it behaves like a conventional flexible coupling; beyond, it permits free-wheeling with impor-

Another Hathaway First... The RS-20 Strain Indicator

The RS-20 is the first strain indicator that indicates strain directly in microinches-per-inch on one large, easy-to-read dial, the first portable strain indicator accurate to ±2 microinches-per-inch. The RS-20 is equipped with resistance and capacitance balancing controls that make it possible to use cables up to 500 feet long. These and other RS-20 features are the product of Hathaway's more than fifteen years experience in the development and design of static and dynamic strain measurement systems.

SPECIFICATIONS

Indication: Strain is read directly in microinches-per-inch from one large dial when using either one or two active gages **Range:** 0 to 20,000 microinches-per-inch **Accuracy:** ± 2 microinches-per-inch **Number of Channels:** 2, 6 or 12 **Balancing Controls:** Resistance and capacitance controls make possible the use of cables up to 500 feet in length **Strain Gage Leads:** Type WA leads allow all bridge connections to be soldered at one gage location **Gage Factor Control:** Can be set to any value from 1.70 to 2.30 **Battery or A.C. Operation:** Self-contained batteries and internal A.C. power supply **Case:** Aluminum, blue hammered glaze finish.

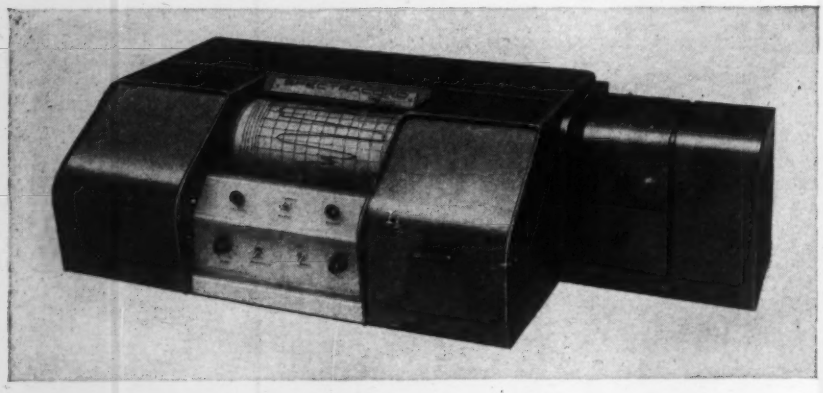
Write for bulletin 3-H-5-H describing the RS-20

See the RS-20 at the 1955 WESCON Exhibit, Booth 1603, and at the 1955 I. S. A. Instrument Exhibit, Booth A275.

Hathaway
INSTRUMENT COMPANY
SUBSIDIARY OF
Hamilton
WATCH COMPANY
1315 SOUTH CLARKSON · DENVER, COLORADO

For more information circle **143** on inquiry card.

the WARREN SPECTRACORD...



EVERY DAY

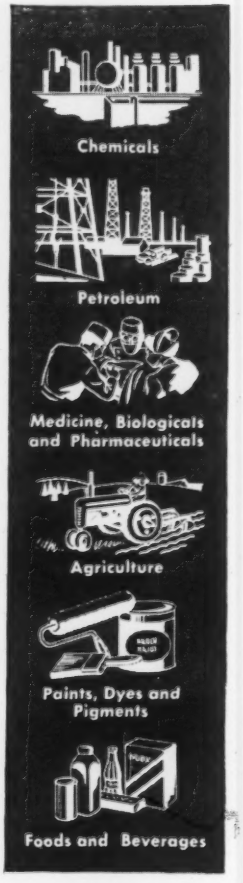
MORE AND MORE laboratories are depending on this versatile instrument as the standard for spectrophotometric measurements. The soundness of the basic design, ruggedness of construction and dependability of operation remain unchallenged.

ULTRAVIOLET, VISUAL AND NEAR INFRARED spectra are obtained with an unsurpassed combination of speed with accuracy.

YEARS OF EXPERIENCE with spectrophotometric problems and their solution by electronic instrumentation are combined to make for the utmost convenience. A non-technical person can quickly make permanent and easy to interpret chemical analyses.

UNMATCHED VERSATILITY extends the skills of researchers and analysts.

COMPLETE DETAILS in your copy of the 20-page "SPECTRACORD Story."



Ask for Brochure No. 408

WARREN Electronics Inc.

Pace-Setter in Spectroscopy

BOUND BROOK, NEW JERSEY, U. S. A.

See the Spectracord at Booth C-504 Instrument Society of America Exhibit, Los Angeles—Sept. 12-16

For more infomation circle **144** on inquiry card.

tant functional properties: (a) ability to use decoupling action in tripping a safety or emergency switch, (b) ability to apply repetitive detent action on which slip effect is based towards a repetitive "hammer-blow" effect, and (c) ability to work as a bidirectional torque coupling with independent torque rating for each direction if required. Units are available in nominal ratings from 24 lb-in. to 100,000 lb-in; all adjustable from 50% to 150% of their nominal ratings.—*Techniflex Corp., Port Jervis, N. Y.*

For more information circle **435** on inquiry card.

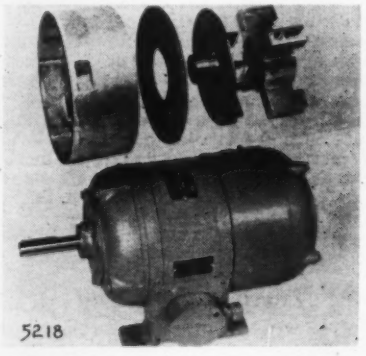
Bearings

New full line of radial bearings, ⅝-in to 1½-in diam, includes stud and bore types with wide choice of race and stud materials; close dimensions and tolerances; minimum of radial and axial play. All come wrapped in polyethylene within containers for cleanliness and protection.—*Grant Pulley & Hardware Corp., 31-85 Whitestone Parkway, Flushing 54, N. Y.*

For more information circle **436** on inquiry card.

Mechanical Motor Brake

New Mechanical Motor Brake, built into motor frame and enclosed in housing, saves much length, avoids



sudden impact on stopping, can be adjusted for rapid or slow stops; also allows for smooth acceleration from standstill to full load; is provided with cooling fans. New brake motors can be installed in any position; can be inched; require minimal maintenance.—*The Cleveland Electric Motor Co., 5213 Chester Avenue, Cleveland 3, Ohio.*

For more information circle **437** on inquiry card.

Precision Clutches

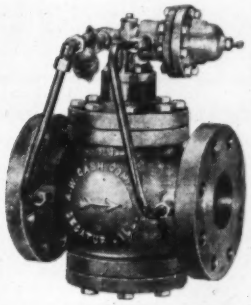
New precision miniature clutches feature positive displacement drive that will transmit up to 10 lb-in of torque at 1800 rpm without external lubrication and at higher speeds in an oil bath. Four basic types: single revolution, over-running, non-reversing, and indexing, each available in sleeve mounts and through-shaft mounts. Maker's use of one standard basic design is said to enable low cost and quick delivery.—*Precision Specialties, 1342 E. 58th St., Kansas City 10, Mo.*

For more information circle **438** on inquiry card.

VALVES

Pilot-operated Valve

New "Type 10" self-contained single-seat pilot-operated control valve with adjustable throttling range fea-

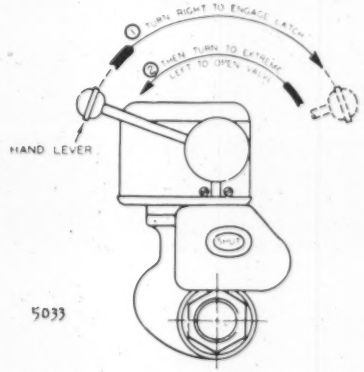


tures easy conversion from a pressure-reducing and -regulating valve to a back-pressure control valve by switching control piping; dial-type range selector gives optimal control for each process.—*A. W. Cash Co., P. O. Box 551, Decatur, Illinois.*

For more information circle **439** on inquiry card.

Manual-reset Valves

New "Fireye Series 81G Manual Reset Valves" are especially designed for

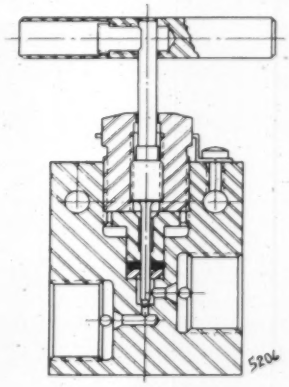


use with flame-failure safeguard systems.—*Electronics Corp. of America, 718 Beacon St., Boston 15, Mass.*

For more information circle **440** on inquiry card.

High-pressure Valve

New 60,000-psi valve, said to provide "far greater safety factors than hitherto available in high pressure valves," embodies improvements in-



Customer and supplier agree...

that, for best results, magnetic performance be defined in terms of the simplest and most readily available instrumentation.

▪ Furthermore, customer and supplier must understand and agree upon all the details of the sampling and testing procedures which each will employ.

▪ At Magnetic Metals Company we take the greatest care in the development and supervision of our magnetic testing procedures. In our quality control we use production test equipment which is accepted throughout the industry as the best for the evaluation of magnetic amplifier cores.

▪ Our experience in this field enables us to provide capable assistance in establishing quality inspection methods for our customers.

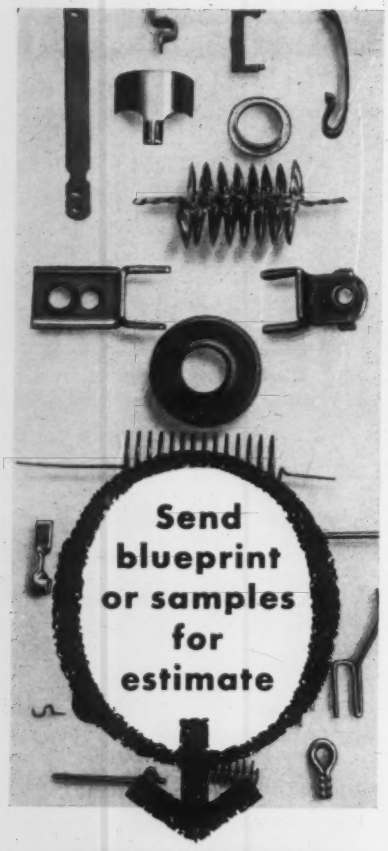
▪ Answers to our customers' questions on measurement and control of magnetic quality are available in our Bulletin E-1. Send your request on your company letterhead.

MAGNETIC METALS COMPANY

electromagnetic cores and shields

HAYES AVENUE AT 21st STREET • CAMDEN 1, N.J.

For more information circle **145** on inquiry card.



WIRE FORMS
and
METAL STAMPINGS

We'll prove that our high speed production means lower unit costs for you!

You'll save two ways — (1) the initial low unit cost made possible by high speed machines; (2) precision and quality control guarantees accurate parts and performance.

STRAIGHTENING AND CUTTING
Perfect straight lengths to 12 feet.
.0015 to .125 diameter.

WIRE FORMS
.0015 to .125 diameter.

SMALL METAL STAMPINGS
.0025 to .035 thickness.
.062 to 3 inches wide.

Specializing in production of parts for electronic, cathode ray tubes and transistors.

Write for illustrated folder.

ART WIRE AND STAMPING COMPANY

5 Boyden Place • Newark, New Jersey

For more information circle **146** on inquiry card.

cluding: (1) collar and gland OD's increased; (2) gland length increased; (3) internal corners machined with a radius and collar corners chamfered to minimize hazard at points of stress concentration; (4) rounded-root threads eliminate possibility of interchanging lower pressure fittings; (5) gland threads relieved to thread base to minimize stress concentration; (6) same with female threads on valves and fittings.—*Autoclave Engineers, Inc., 850 E. 19th St., Erie, Pa.*

For more information circle **441** on inquiry card.

MISCELLANEOUS

Plastic Foam Platforms

New "Polyform Packers" prefabricated polystyrene foam platforms with recesses cut for snug fit are said to provide functional as well as attractive display advantages in packaging of instruments and components. Wide variety of shapes and specs.—*Glo-Brite Products, 6417 N. California Ave., Chicago 45, Ill.*

For more information circle **442** on inquiry card.

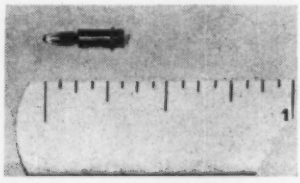
High-temperature Wire

New "Type 350 General Purpose High Temperature Aircraft Wire" operates satisfactorily at temperatures from –80°F to 400°F at 40,000 feet and higher; resists solvents and engine lubricants and fuels; is flexible at extremely low temperatures; is smokeless; will not discolor at maximum operating cable temperature; is flame-resistant; is free stripping.—*The Electric Auto-Lite Co., Toledo 1, Ohio.*

For more information circle **443** on inquiry card.

Miniature Lamps

New complete line of "grain of wheat" lamps in sizes as small as ¼-in over-all length includes units in



both screw and bayonet bases in a variety of electrical ratings.—*Schueller & Co., 75 Cliff Street, New York 38, N. Y.*

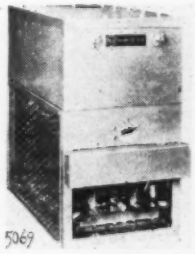
For more information circle **444** on inquiry card.

Industrial Microphone

New "MI-2630 Series" microphone is particularly suited for noisy, dusty or moist environments; is available with or without maker's nameplate. Frequency characteristic is flatter than most, with a slight rise toward high end and a fairly abrupt drop off after 3500 cps. Snap-action switch is operated through a rubber diaphragm. Various switches, numbers of conductors, wiring patterns and plugs available.—*Femco, Inc., Irwin, Penna.*

For more information circle **445** on inquiry card.

Automatic Air Dryers



New self-contained mechanically-refrigerated air dryers provide clean dry air output from 4 cfm up to 55 cfm. Five models: ¼, ¾, 1½, 3 and 5 hp. Among features: completely automatic; require no attention or manual reactivation because drying process is accomplished mechanically and automatic cycling controls are provided; remove moisture by a condensation process which removes entrapped oil and provides a relatively pure and dry air output.—*Murphy & Miller, Inc., 1326 So. Michigan Ave., Chicago, Ill.*

For more information circle **446** on inquiry card.

High Power/volume Ratio Instrument Cell

New "Indium Cell" drives maker's experimental "electronic wrist watch" for two years at virtually constant voltage; is inherently free of parasitic reactions during storage and discharge. Its characteristics are constant between 0°F and 120°F.—*Elgin National Watch Co., Elgin, Illinois.*

For more information circle **447** on inquiry card.

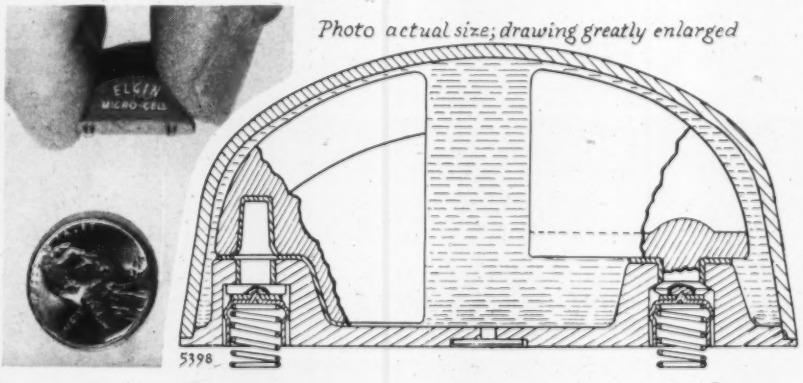
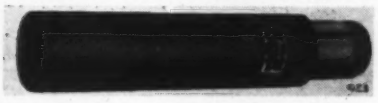


Photo actual size; drawing greatly enlarged

TV-tube Dot-pattern Microscope

New "Color TV Tubescope" simplifies alignment of dot pattern on picture tube during manufacture and on



field service calls. Five interchangeable eyepieces, 10X to 33X. Scope is 7¼ in. long and comes with leather case.—*Edmund Scientific Corp., Barrington 3, N. J.*

For more information circle **448** on inquiry card.

Explosive-gas Indicators

New "Page Sensor," for use where a quick "go, no-go" spot check for combustible gases or vapors is needed, operates on two pen light cells. To use,

it is removed from its plastic case and the light bulb (which acts as a switch) is pressed. A trace of combustible causes light to flash intermittently. As concentration of combustibles increases, flashing becomes more rapid, until a steady bright light indicates hazard.—*Davis Emergency Equipment Co., 47 Halleck Street, Newark, N. J.* (east of Mississippi); *Hogart Engineering Co., 1050 S. Olive St., Los Angeles, Calif.* (W. of Mississippi).

For more information circle **449** on inquiry card.

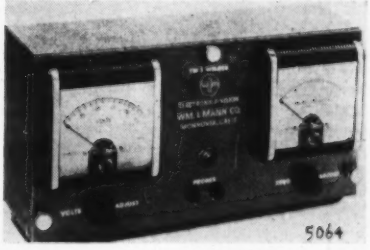
Time Switch

New 24-hour time switch, for marginal operation of oil well pumps, accurate cycling of processing equipment, HV&AC systems, stokers, oil and gas burners, etc., has dial scaled in 15-minute graduations which can be set for as many as 48 "on" and 48 "off" operations, automatically repeating a 24-hour schedule. Rated capacity 1000 watts. Operates on 60 cps 110- or 240-v.—*Dep't IUP, Zenith Electric Co., 152 W. Walton St., Chicago 10, Ill.*

For more information circle **450** on inquiry card.

Electronic Welder

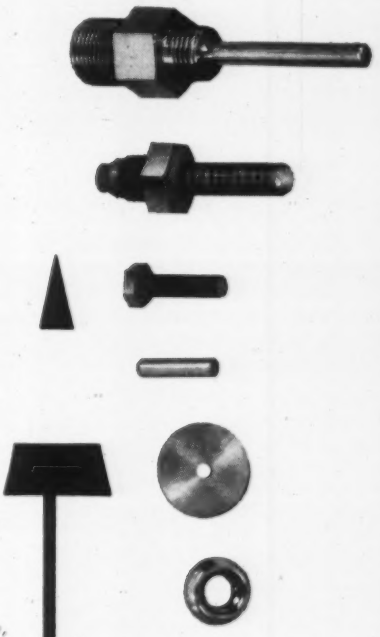
New "TW-1," for welding resistance wire of 0.0007 to 0.025 in., is designed for production line use where con-



TME –

HIGH SIGNAL OUTPUT TEMPERATURE MEASURING EQUIPMENT

Provides 5-VOLT signals for as little as 150°F. temperature change without amplification using High-resistance (20,000 ohms) probes. Probes are available for measuring surface, structure, air, component, fuel or hydraulic temperatures. Write for complete details.



ARNOUX CORP.

P.O. BOX 34628A

LOS ANGELES, CALIFORNIA

For more information circle **147** on inquiry card.

FLIGHT INSTRUMENTATION by RAHM

potentiometer type transducers for use at temperatures between −60° C. and +120° C.

- PRESSURE
- ALTITUDE
- AIRSPEED

Designs available for operation to 160° C.

Designs available permit single or multiple range linear output from non-linear input function, and operation over wide ranges of environmental conditions.

- ACCELERATION
- PRESSURE SWITCHING
- ALTITUDE CONTROL

Request Catalog #954

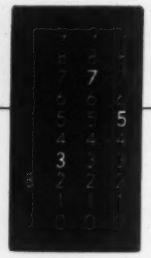
RAHM INSTRUMENTS, INC.

12 WEST BROADWAY, NEW YORK 7, N. Y.

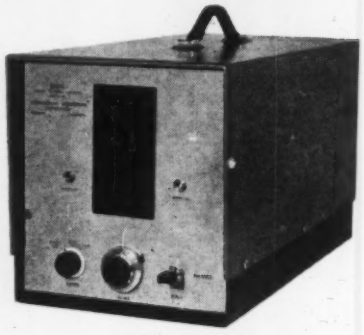
For more information circle **148** on inquiry card.

New low-cost

DIGITAL VOLTMETER



SADIC DIGITAL VOLTMETER (TYPE 33-110) is CEC's newest unit for low-voltage analog-to-digital conversion. It offers true economy plus high accuracy. Output includes illuminated numerical display (above) and decimal-coded contact closures. Suitable for bench use or rack mounting (two units fit side by side in 19" rack) the 33-110 is useful for both laboratory indication and as a building block for automatic data-processing systems.



SPECIFICATIONS

...digital range	000 to 999 (1000 steps)
...accuracy	1/10th % of full scale
...sensitivity	10 millivolts provides full-scale output
...balance time	0.8 second, max.
...power source	105-115 volts a-c

Send for Bulletin CEC 3009-X2

Consolidated Engineering

Corporation

300 North Sierra Madre Villa, Pasadena 15, California

Sales and Service Offices Located in: *Albuquerque, Atlanta, Boston, Buffalo, Chicago, Dallas, Detroit, New York, Pasadena, Philadelphia, San Francisco, Seattle, Washington, D. C.*

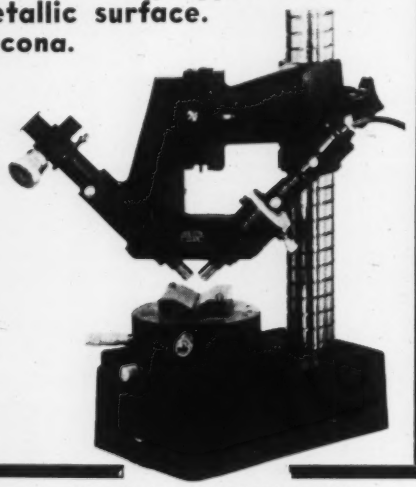
For more infomation circle **149** on inquiry card.

For NON-DESTRUCTIVE inspection and depth of roughness measurements of every type of metallic and non-metallic surface. Available only from Ercona.

CARL ZEISS JENA

SURFACE FINISH TESTER

Optical slit microscope design by Prof. Schmaltz employing "light section" method which produces a true optical section of the surface and permits accurate analysis of surface structure and direct measurement of depth of roughness.



STANDARD PHOTOMICROGRAPHIC CAMERA ATTACHMENTS make possible permanent records of surface profiles for reference or comparison.

Magnification range: 60X to 520X.
Measurable roughness range: .001 to .00002 ins.
Measuring precision, with measurement repeated and mean taken: plus/minus (.03 R plus .000003) ins. R being maximum depth of roughness.

OTHER CARL ZEISS JENA INDUSTRIAL PRECISION MEASURING INSTRUMENTS

Shop Microscopes • Toolmakers Microscopes • Indicating Snap Gauges • Indicating Micrometers • Optical Dividing Heads • Optical & Mechanical Comparators

Scientific Instrument Division

ERCONA CAMERA CORP. 551 Fifth Avenue • New York 17, N. Y.

For more information circle **225** on inquiry card.

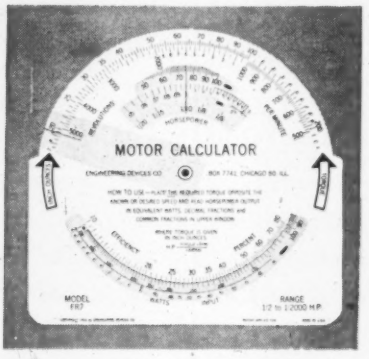
NEW INSTRUMENTS

sistent direct wire-to-wire and wire-to-element welds are demanded without applying pressure. Among features: ohmmeter for measuring tap resistances (and others) independent of welding operations; automatic switch removing ohmmeter from welding circuit when foot switch is depressed; voltmeter facilitating accurate adjustment of welding current. —*Wm. J. Mann Co., 104 E. Foothill Blvd., Monrovia, Calif.*

For more information circle **451** on inquiry card.

Motor Calculator

New "Model FR7" direct-reading motor calculator replaces, by one setting, seven operations with a conventional slide rule. Setting for any relationship of speed vs torque gives equivalent watts output and horse-

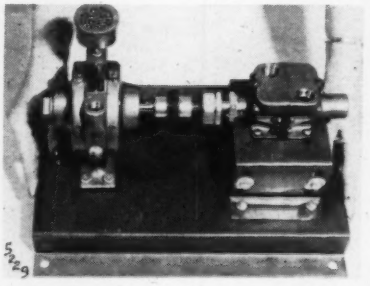


power in decimal and common fractions, also percent efficiency for any value of watts input. "FR7" covers hp range from 1/2000 to ½ hp. Other hp range models available.—*Engineering Devices Co., P. O. Box 7741, Chicago 80, Ill.*

For more information circle **452** on inquiry card.

Air-motor-and-pump

New explosion-proof pump unit designed to handle corrosive and hazardous materials is driven by a manually-

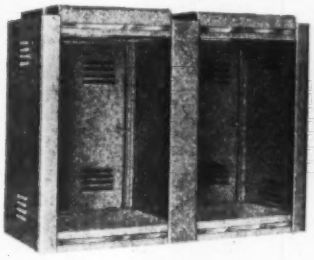


adjustable air motor, with pumping speed closely controllable. Required air pressure 40 to 100 psig. Reversible air motors are available. Use of a flexible hose connection for compressed air makes unit become portable. Pump is maker's positive-displacement stainless-steel "All-Chem" with chemically inert mechanical seal; optional modifications include several alloys and non-metallic rotors, and new Teflon-ceramic shaft seal. Flow rates to 10 gpm at pressures to 100 psig.—*Eco Engineering Co., 12 New York Ave., Newark 1, N. J.*

For more information circle **453** on inquiry card.

Multiple Relay-rack

New multiple relay rack unit enables enclosed relay racks for standard 19-in. rack panels to be joined to-



gether: solid center partition bolted to top and bottom. Each multiple section consists of a top, bottom, rear door and center partition. Four sizes: 36¾, 42, 61¼ and 77 in; each in standard, rounded type and deluxe racks.—*Premier Metal Products Co., 3160 Webster Ave., New York 67, N. Y.*

For more information circle **454** on inquiry card.

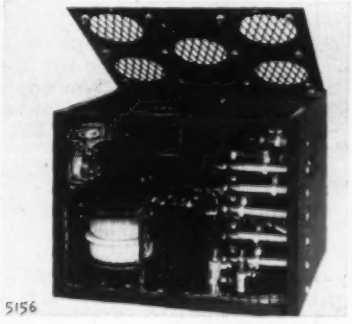
Protective Coating

New "Laqua" is a coating for metals that preserves chemically-cleaned surfaces obtained directly after electroplating or a chemical cleaning operation. It can be sprayed on a clean surface or be applied as a dip after a final water rinse without drying. This is possible because it displaces water as it deposits a thin protective film. "Laqua" has the same electrical resistance as an oxide film formed on aluminum in eight hours at room temperature. This resistance remains constant with aging. "Laqua" is said to improve and speed soldering operations; and cadmium-plated and aluminum parts coated with it can be spot-welded without fear of harming normal strength of weld.—*Fidelity Chemical Products Corp., 470-474 Frelinghuysen Avenue, Newark, N. J.*

For more information circle **455** on inquiry card.

Voltage Regulators

New magnetic-amplifier-type voltage regulators are suitable for alternators, etc. Illustrated typical unit



5156

has following specs: ac input 120v single phase, 400 cps; va rating 50; dc output 15-150 volts @ 0.05-0.5 amp (to fields of exciter); voltage adjustment 10%; regulation accuracy 1%; approx. weight 35 lbs.—*Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.*

For more information circle **456** on inquiry card.

New! SIMPLEX

SQUEEZE CONTROLLER

Accurately regulates flow of liquids containing suspended solids or trade wastes—with no effect on moving parts!

A Simplex venturi tube, the most accurate form of primary device, does double duty—measures as it controls.

Special throat section is *flexible rubber.* If flow tends to change, motor-driven clamping device adjusts throat area—quickly returns flow to control point.

Throat section is self-scouring. Viscous fluids contact no moving parts.

Write for full details today!

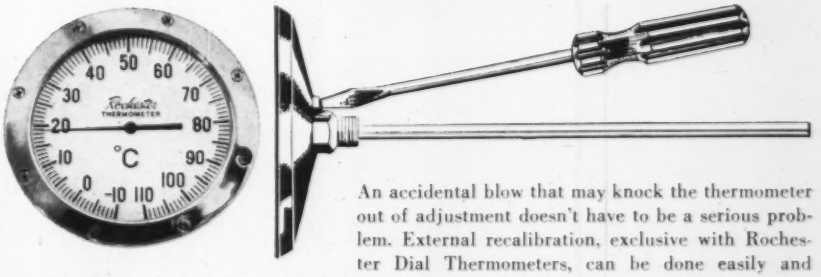
Simplex Valve & Meter Company, Dept. IA-8
7 E. Orange St., Lancaster, Pa.

IT'S SIMPLEX IT'S ACCURATE

SIMPLEX®
VALVE AND METER COMPANY

For more information circle 152 on inquiry card.

EXCLUSIVE! YOU CAN RECALIBRATE THE ROCHESTER DIAL THERMOMETER EXTERNALLY . . .



An accidental blow that may knock the thermometer out of adjustment doesn't have to be a serious problem. External recalibration, exclusive with Rochester Dial Thermometers, can be done easily and quickly. Insert the stainless steel stem in any liquid of known temperature and adjust the dial with the set screw attachment. It's done easily and quickly, EXTERNALLY, and is completely accurate.

Other plus features include:

All parts, except the crystal, are of corrosion-resistant stainless steel.
Hermetically sealed against moisture and grime.
All readings are completely legible and accurate.
Precision bi-metal helices precalibrated to dial before assembly.
Stem position can be located anywhere around circumference of the dial in the STRAIGHT form thermometers.

Your Rochester representative will be glad to give you additional information, or address your inquiries directly to the Rochester Manufacturing Company. Rochester . . .

Rochester Manufacturing Company, Inc.
35 Rockwood St., Rochester 10, N. Y.

ROCHESTER GAUGES

DIAL THERMOMETERS GAUGES AMMETERS

For more information circle **153** on inquiry card.

Events . . .

For Other Computer Events see page 1311.

INSTRUMENTS and AUTOMATION

August 29-September 2

Fisk University Infrared Spectroscopy Institute, Fisk University, Nashville, Tenn. For information contact Nelson Fuson, Fisk University, Nashville 8, Tenn.

September 10-12

Instrument Maintenance Clinic, Founders Hall, University of Southern California, Los Angeles, Calif., offers choice of three schedules each consisting of balanced series of eight different instruments. Certificate issued to each registrant who completes course. For information contact Instrument Society of America, 1319 Allegheny Ave., Pittsburgh 33, Pa.

September 12-16

Tenth Annual Conference and Exhibit of the Instrument Society of America will be held at Shrine Exposition Hall and Auditorium, Los Angeles, Calif. For information write Fred J. Tabery, 3443 South Hill St., Los Angeles 7, Calif.

September 14-16

Annual General Meeting of the Association for Computing Machinery, Moore School of Electrical Engineering, University of Pennsylvania, Phila. For information write Sidney Kaplan, R.C.A., Building 13-2, Camden 2, N. J.

September 14-16

Second National Annual Meeting of the Institute of Radio Engineers Professional Group on Nuclear Science, Oak Ridge, Tenn. For information contact H. E. Banta, Oak Ridge National Laboratory, P. O. Box P, Oak Ridge, Tenn.

September 19-21

Network Analyzer Short Courses, Electrical Engineering Building, Iowa State College, Ames, Iowa. For information contact Engineering Extension Service, Iowa State College, Ames, Iowa.

September 20-23

Fourth Beinnial of High Precision at the Chambre Syndicale Nationale de la Mécanique de Haute Précision, 37 Avenue de Breteuil, Paris, France.

September 28-29

Industrial Electronics Conference, Rackham Memorial Auditorium in Detroit, Michigan. For information contact Guido Ferrara, 8106 West Nine Mile Rd., Oak Park 37, Mich.

September 28-30

Sixth TAPPI Testing Conference including Instrument Exhibition at Sheraton-Kimball Hotel, Springfield, Mass. For information contact Wm. Schoenberg, 1878 E. 18th St., Cleveland 14, Ohio.

October 3-5

11th Annual National Electronics Conference, Hotel Sherman, Chicago, Ill. For information write J. Kocek, c/o Illinois Bell Telephone Co., 208 W. Washington St., Rm 300, Chicago 6, Ill.

October 3-6

25th Annual Meeting of Society of Exploration Geophysicists, Shirley Savoy Hotel, Denver, Colo. For information write Colin Cambell, 624 S. Cheyenne, Tulsa, Oklahoma.

October 5-14

Tenth General Conference on Weights and Measures will be held in Paris and Sevres, France. For information write National Bureau of Standards, U. S. Dept. of Commerce, Washington 25, D.C.

October 13-15

Committee on Vacuum Techniques, Inc., will hold their Second Symposium on Vacuum Technology at Mellon Institute, Pittsburgh 13, Penna. For information write Rudy Koehler, c/o Box 1282, Boston 9, Mass.

October 24-25

First Annual Technical Meeting of the Professional Group on Electron Devices of the I.R.E., will be held at The Shoreham Hotel, Washington, D.C.

October 27-28

Eleventh Annual Meeting of National Conference on Industrial Hydraulics, LaSalle Hotel, Chicago, Ill., will feature a Computer Session on Thursday morning, the 27th. For information contact R. J. King, c/o Technology Center, 3300 S. Federal, Chicago 16, Ill.

October 28-29

1955 Philadelphia ISA Section Symposium "Automatic Control Loops—Electronic or Pneumatic?", at the Penn Sherwood Hotel, Phila., Pa. For information write c/o R. F. Eisele, Leeds & Northrup Co., 4907 Stenton Ave., Phila. 44, Pa.

October 31-November 1

International Conference on Scientific Basis of Applied Solar Energy, University of Arizona, Tuscon, Arizona as a prelude to the World Symposium on Applied Solar Energy to be held in Phoenix, Nov. 2-4. For information contact Symposium Headquarters, Suite 204, Mayer-Heard Bldg., Phoenix, Arizona.

November 1-5

SRI, Association for Applied Solar Energy and University of Arizona World Symposium on Applied Solar Energy, Westward-Ho, Phoenix, Arizona. For information write Public Relations Dept., Stanford Research Institute, Stanford, Calif.

November 3-4

Eighth Annual Electronics Conference sponsored by the Kansas City Sec. IRE, Town House, Kansas City, Kan. For information write P. O. Box 391, Kansas City 41, Missouri.

November 3-4

Fourth Annual Louisiana Polytechnic Institute Instruments Conference, Ruston, Louisiana. For information write School of Engineering.

November 7-9

Eastern Joint Computer Conference and Exhibition sponsored by AIEE, IRE and ACM, Hotel Statler, Boston, Mass. For information write Box 223, Boston 1, Mass.

November 9-11

Nineteenth Annual Time and Motion Study and Management Clinic, Sherman Hotel, Chicago, Ill. For information write Industrial Management Society, 35 E. Wacker Dr., Chicago 1, Ill.

November 13-18

American Society of Mechanical Engineers' 75th Annual Meeting, Hotel Congress, Chicago, Ill.

November 14-17

Second International Automation Exposition will be held at Chicago's Navy Pier. For information write The Second International Automation Exposition, 845 Ridge Ave., Pittsburgh 12, Penna.

November 16-18

Society for Experimental Stress Analysis meeting and exhibit, Hotel Sheraton, Chicago, Ill. For information write J. J. McDonald, Consolidated Engineering Corp., 919 N. Michigan Ave., Chicago, Ill.

November 17-18

Tenth Mid-West Conference of American Society for Quality Control, Schroeder Hotel, Milwaukee, Wis. For information contact R. H. Byrnes, 3402-A N. Humbolt Ave., Milwaukee, Wis.

November 28-30

Professional Group on Instrumentation, Atlanta Sec. of I.R.E. Instrumentation Conference, Biltmore Hotel, Atlanta, Ga. For information contact D. L. Finn, School of Electrical Engineering, Georgia Institute of Technology, Atlanta, Ga.

January 9-10

Second National Symposium on Reliability and Quality Control in Electronics, Hotel Statler, Washington, D. C. For information contact V. Wouk, Beta Electric Corp., 333 E. 103rd St., New York 29, N. Y.

January 19-21

Dallas-Fort Worth Chapter of IRE Professional Group on Electronic Computers National Simulation Conference, Dallas, Texas. For information contact J. R. Forester, 2104 Huntington, Arlington, Texas.

March 19-23

American Society of Tool Engineers' Industrial Exposition, Chicago International Amphitheatre, Chicago, Ill. For information contact ASTE Industrial Exposition, 10700 Puritan Ave. Detroit 38, Mich.

SEE THESE TWO NEW Bendix COMPLEMENTARY PROCESS CONTROLS

at the Instrument-Automation Conference
Sept. 12-16, 1955
Los Angeles, Calif.

Continuous and Automatic

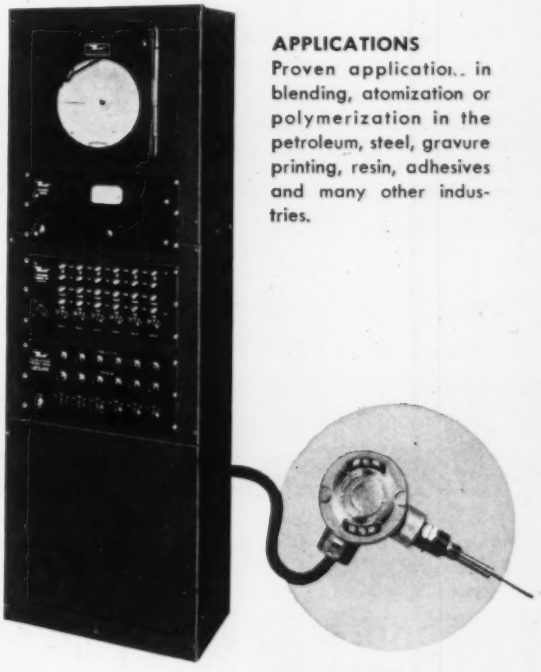
NUCLEAR DENSITY GAGE

Sensing element not in contact with process fluid; ideal for corrosive, abrasive and viscous liquid systems.

APPLICATIONS

- Density
- Specific Gravity
- Liquid Concentration
- Per Cent Solids
- Vapor/Liquid Ratio
- Liquid Level
- Interface Detection

MULTIPOINT ULTRA-VISCOSON ELECTRONIC VISCOMETER



APPLICATIONS

Proven application in blending, atomization or polymerization in the petroleum, steel, gravure printing, resin, adhesives and many other industries.

Probes hermetically sealed —no moving parts.

CABINET SPECIFICATIONS

Standard rack panel mounting; dust-proof; air purgable (air purge kit available from Bendix).

Features:

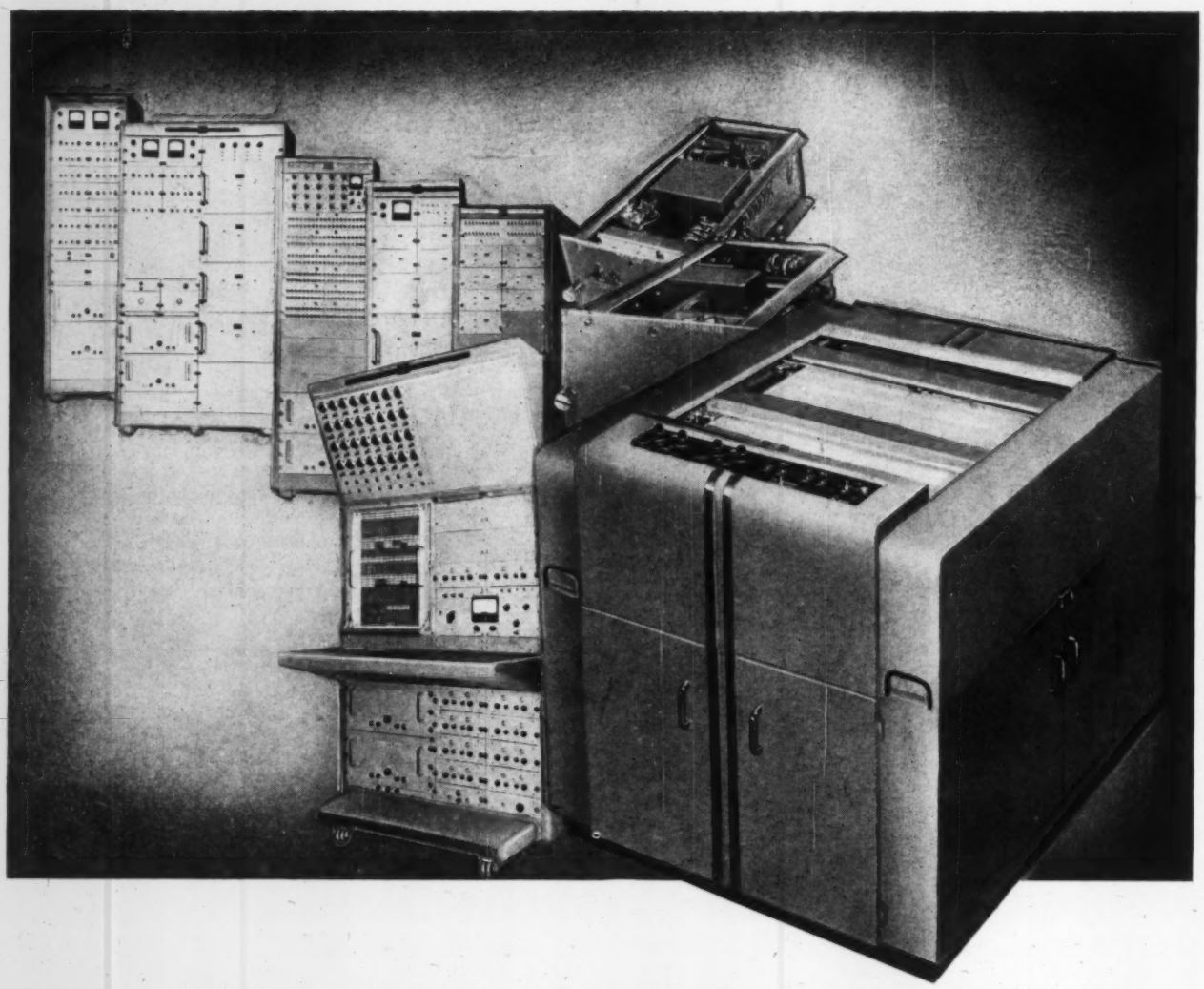
The Bendix Nuclear Density Gage is designed for process pipelines. Range, Span and Time Constant adjustments on front panel. Meets every AEC requirement for industrial use. Range: 0.3 to 3.5 Sp. Gr. range with a minimum span of 0.2 Sp. Gr.

The Bendix Multipoint Ultra-Viscoson* electronic viscometer controls one to six individual stations. Automatic or manual selection of probe stations. Automatic or manual control of valves. Installation in pipelines, kettles, reactors. Ranges: 0—500,000 centipoises x grams/cc.

*REG. U.S. PAT. OFF.

Cincinnati Division, Bendix Aviation Corporation, 203 W. Third St., Cincinnati 2, Ohio

For more information circle **27** on inquiry card.



FROM PROBLEM CHECKS AND AUTOMATIC READOUTS TO THE FAMOUS VARIPLOTTER...A COMPLETE LINE OF ACCESSORIES

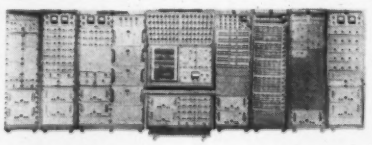
As your computational work loads expand and change, it becomes imperative that you be able to supplement your computing system with needed accessories.

This, say engineers, is one of the greatest advantages of Electronic Associates' Computing systems—for EAI makes available a complete line of accessory equipment. For example, Problem Checks that permit you to check directly from the equation before the problem is run, without disturbing the problem set up.

Also automatic readouts, high-speed servos, powerful amplifiers. All with the same attention to detail and quality that is represented in the new Variplotter plotting equipment. A self-balancing potentiometer type X vs. Y recorder, this new model has convenient table-top controls, vacuum hold-down system, high speed and accuracy.

A computation center is maintained by Electronic Associates in Princeton, New Jersey, where you may observe this equipment in operation and rent computation time. Brochures are also available. Write Dep't. IA-10, Electronic Associates, Inc., Long Branch, New Jersey.

Expanded 16-31R Analog Computer



ELECTRONIC ASSOCIATES *Incorporated*

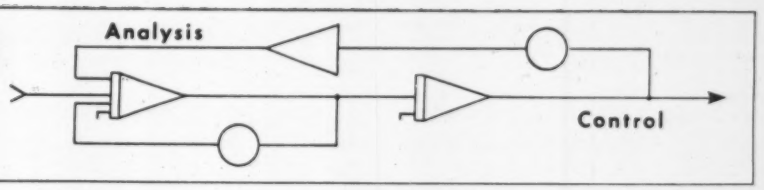
EAI SETS THE PACE

PRECISION ANALOG COMPUTING EQUIPMENT

LONG BRANCH, NEW JERSEY

For more information circle **154** on inquiry card.

The SIMULATION COUNCIL Newsletter



John H. McLeod, Jr., EDITOR

Suzette McLeod, SECRETARY

Western Simulation Council
Norman L. Irvine, Aerojet-General Corporation, Azusa, Calif.; Chairman, Steering Committee.

Midwestern Simulation Council
R. R. Weber, Cincinnati Milling Machine Co., Cincinnati, Ohio; Chairman, Steering Committee.

Eastern Simulation Council
Harold K. Skramstad, National Bureau of Standards, Washington, D.C.; Chairman, Steering Committee.

Bits

Oh, for the life of an editor! Yesterday I had a deadline breathing down my neck and nothing to write about. On the way to the WSC I stopped by the post office and found Charlie Morrill's writeup of the MSC *and* Ro Favreau's of the ESC. To cap this off, Stu Schy phoned that he was putting the long-awaited transcript of the Industrial Analysis and Control Council panel discussion of "Possible Effects of Automation on our Way of Life" in the mail. So, counting the WSC meeting, which I got on tape later in the day, I now have four things to tell you about—and only one *Newsletter!*

Because the IACC panel discussion will take considerable work to get into shape for publication, and because the speaking members of the ESC have not yet had a chance to check Ro's writeup, I will hold these stories for next month. Here is a condensation of Charlie's MSC story together with our own subminiaturized version of the goings-on of the WSC at Naval Ordnance Lab, Corona.

Pieces

SIXTH MEETING OF THE MIDWESTERN SIMULATION COUNCIL
by C. D. Morrill

On the afternoon of 20 June 1955 "Operation of a Computing Facility" was discussed at Armour Institute of Technology in Chicago.

Warshawsky on Operation of a Computer Facility

Milt Warshawsky (Wright Air Development Center, Wright-Patterson Air Force Base, Ohio) gave the keynote talk. As he put it, questions to be considered in the operation of a facility are:

1. How and in what form will problems be received and assigned? This depends on who the "customers" are and the criteria for assigning problems to various sections.
2. To what extent will the "customer" participate in problem planning, programming, and solution?
3. What methods of programming problems will be used?
4. What method or methods will be used to check solutions?
5. What will be the extent of services performed? For example, will only designated solutions be obtained, or will the service include a consulting and advisory phase?
6. What maintenance procedures will be employed?

ARL Facility of WADC

Milt then described the facility of the Aeronautical Research Laboratory at Wright Air Development Center and their approach to the problems. For easier assimilation, the amount of equipment, personnel, etc., has been combined with the information provided by other speakers in the accompanying table (next page).

The operating procedures at ARL-WADC are as follows:

1. The WADC project engineer contacts the laboratory chief to discuss the nature of the problem, equipment requirements (analog or digital), etc. If it is agreed that an analog solution is desirable, the red tape involved in getting the work started is almost zero.*
2. Larger and/or nastier problems are assigned to a team of two suited, if possible, to the type of problem involved. This team carries the problem through from start to finish, including formulation, programming, scaling, wiring computer, checking solution(s), writing reports.
3. During the machine phase a representative of the customer is present to monitor the solutions, modify the program if the original program appears to be generating useless solutions and, particularly, to check the reasonableness of solutions.

A machine check employed at

*An Air Force innovation, no doubt! If this be true, the Air Force is *really* making progress.

ARL-WADC involves setting up a series of identical second-order-differential equations, using all or almost all components, and comparing the answers. This method has proved very sensitive to machine malfunctions.

All speakers emphasized the value of "checking the reasonableness"* of solutions. In defense of this method, Milt stated that when analog computers (and their operators) make a mistake it's generally a gross one and, thus, *easily detected by someone familiar with the physical nature of the problem!* Another inference by the speakers was that solutions by general-purpose digital computers are generally worthless because, by the time they are obtained, the show is over. Because of this, ARL-WADC is procuring two digital differential analyzers to be programmed by the Analog Section concurrently with the analog solution.

In answer to questions from the group, Milt added that although some problems may take only a dozen amplifiers, a representative problem will require 60-70 amplifiers (see table); the first successful run on such a problem will normally be four or five days after the patch board is placed on the computer; problems are normally allowed no more than two weeks on the computer, even if things are "just starting to get good"—incomplete problems have to be rescheduled.

*Or as Bob Bemer would put it, "Use your head!"

Bauer on Cyclone

The second speaker was Louis Bauer of Cyclone (owned by the Bureau of Aeronautics and operated by Reeves Instrument Corporation). Although the problems are mostly missile and aircraft, the size of the problems and the machine time are quite variable. Louis gave two extreme examples:

The first one required 30 amplifiers, 3 resolvers, 2 limiters, one diode function-generator. The problem was received on the 23 February, set up by 1 March, first run and check on 7 March, 1000 runs made by 18 March, and a final report completed by 19 April.

The second example required about 200 amplifiers and a corresponding quantity of nonlinear equipment—about 20 cabinets. The problem was received in August. There followed months of correspondence, conferences, and modifications. Programming began in October, setup in December. The first correct solution was obtained in February. More modifications and a new check solution by May; the job was completed by the following December, with final report yet to be written.*

Hermann on DSCL

The third speaker was Paul Hermann (Goodyear Aircraft Corporation, Akron, Ohio). Goodyear's facility, the Dynamic Systems and Computation Laboratory, generally services only its own contracts. The majority of the equipment is Government-owned, on bailment to GAC for use on particular contracts. Because of this and the nature of some of the work, part of DSCL's operation is quite different from that of the facilities represented by the other speakers. Part of the DSCL facility becomes what almost amounts to a fixed-purpose computer even though, through use of problem boards, machines can be switched to other problems (some of them will be simulating the same system most of the time). New ideas, system modifications, statistical studies, etc., will be tried out on these computers. Problems seldom take less than a week. Some projects have had a problem running for five or six years.

*This "months of correspondence" can become so serious that it often makes "simulation by remote control" completely impractical. This seems to be true even if "remote" is not true in the geographical sense, but only implies a difficulty in communication between the man with the problem and those doing the simulation. Effective simulation requires close cooperation.

TABLE 1.—EQUIPMENT, PERSONNEL, AND PROBLEMS OF COMPUTING FACILITIES

Facility	Amount of Equipment							Personnel		Types of Problems (2), (4)	Avail. of Dig. Eqpt.	Checking Procedures Employed (2), (3)	Size of Problems (Amp)	
	Amp	El. Mult. Ch.	Servos[1]	Res.	F. G.	Plotters	Recording Channels	Oper.	Maint.				Typical	Largest
ARL, WADC	208	54	[illegible]	4	18	4	24	7	3	a, c	Yes	g, a, b, c, d, e, h	60-70	100
Cyclone, Reeves	556	0	23*	35*	18	9	48	18	11**	a	Yes	e, a, b, c, d, g	100-150	304
DSCL, Goodyear	400	39	24	Incl. In Servos	7	3	40	15	2	a, b, c	Yes	g, a, b, d, h, e	30-40	100
PCC, Electronic Associates	96	0	20	4	20	2	18	4	3	b, a, c	No	a, b, d, e, g	40-80	96

NOTES
(1.) Including Tapped Pot Servos
(2.) In order of time spent
(3.) Coded as follows:
a. Check of the machine
b. Check of minor loops in the problem
c. Initial condition check
d. Analytical solution of linearized equations
e. Solution on digital computer
f. Use of digital differential analyzer
g. Reasonableness of solution
h. Prayer
(4.) Coded as follows:
a. Military systems
b. Industrial systems
c. Component studies

*58 independent servo shaft rotations; All servos have multiplying potentiometers; 35 of these servos have one or more resolvers

**This number includes 8 engineers engaged in research and development.

Another departure from the operating methods of other groups is that one or two machines will be loaned to a group for certain operations. The machines will be wheeled into another area for connection with other equipment for partial simulation of a system. In this mode of operation the computer functions almost as a piece of dynamic test equipment.

In general, however, DSCL favors concentrating the computing equipment in one place, to be operated by computing experts with as much assistance from the projects served as seems desirable. The advantages, listed by Paul, are:

1. Concentration of expensive equipment for wide application.
2. A specialized group of experts to obtain maximum utilization of equipment.
3. Efficient use of maintenance personnel.
4. More efficient use of special equipment (timers, programmers, comparators) and commercial power.

Concerning DSCL personnel, Paul felt that a person having a strong analytical aptitude with a good engineering background is best suited to this type of work because he is able to think in terms of analogous systems and is less dependent on mathematical formulation of problems.

At times the DSCL has become a sort of training group. Other groups have sent new persons to the DSCL to learn computing, and DSCL personnel have left the group to go into other projects. This has been helpful in stimulating the better utilization of the computers.

Conventional checking procedure is used, with reliance being placed primarily on the knowledge, skill, and intuition of the simulation engineer.

DSCL relies heavily on preventive maintenance. About once every three or four months each machine goes through a severe check and minor overhaul. Of course the technicians are always available for immediate—or crash—maintenance.

Favreau on PCC

Ro Favreau of Electronic Associates' Princeton Computation Center described his facility, the service of which is available to all on a fee basis. By the nature of the facility and the work they do, Ro and his people are required to spend more time than most in educating the customer on the principles, capabilities, limitations, and techniques of analog computers. Like the others, they feel that it is most desirable to have a customer representative take active part in the problem solution because this aids in transferring information.

Details on the PCC and the other computing facilities are tabulated in Table 1.

MEETING OF THE WESTERN SIMULATION COUNCIL AT NOL-CORONA

Forty-one people representing 17 organizations met at the Naval Ordnance Laboratory in Corona, California for the meeting of the Western Simulation Council on 14 July 1955. We had been rather dismayed by the weatherman's prediction of 98° for that area (it seldom gets hotter than 80° along the coast where we usually operate). But the humidity was so low and the breeze so pleasant (both outside and inside the "discussion" area) that the heat was not at all objectionable.

Some of you may remember that the subject advertised for discussion was a continuation of the May meeting topic concerning the use of computers for system optimization. We didn't talk about that!

After our welcome by *Dr. F. S. Atchison*, Technical Director of NOL, a few remarks and queries (including a direct question to Dr. Atchison as to what "optimization" meant to him) by Norm Irvine—Chairman of the Steering Committee, who was to lead the discussion—revealed that everyone had come to *hear* about optimization and no one to *talk* about it!

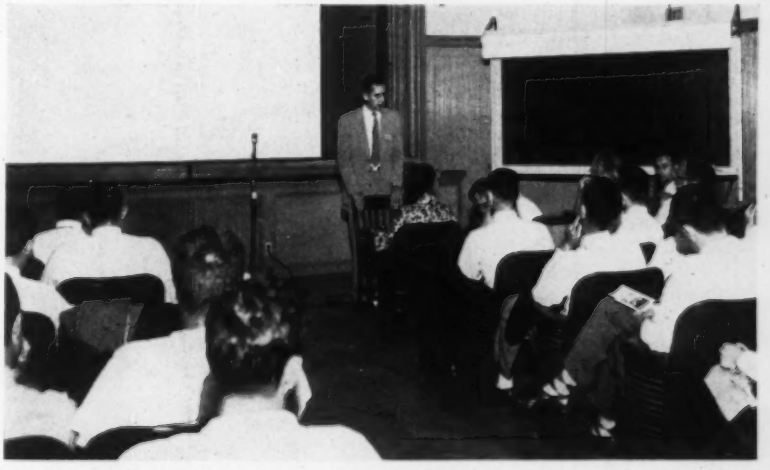
Irvine on Simulation of Dead Time

So Norm adroitly shifted the subject to something someone (namely Norm) did know about, and one about which considerable interest had been evinced—the simulation of "dead time." Because Norm is preparing a paper surveying the various methods of creating time delays, and because we are able to give you several references (see Information), we will not give you the details of our discussion, but only a few remarks to indicate the aspects of the subject which were considered.

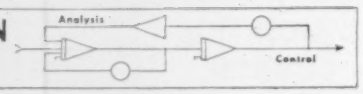
To be sure we were all talking about the same thing, *R. K. Seferian* (North American Aviation, Inc., Slauson Ave., Los Angeles, Calif.) made a point of distinguishing between time lag and time delay (or dead time, transport lag, etc.). Specifically, if he introduced a square wave into this gadget he was looking for he wanted to get a square wave out at some time of his choice (T) later. (Wouldn't we all!) Furthermore, he wanted to get away from the most obvious answer, tape. He, Norm, and Otis Updike (Naval Air Missile Test Center, Pt. Mugu, Calif.) then got into a discussion with blackboard graphs, equations, and Bode diagrams which showed that the mathematical expression for the transfer function desired is:

$E_o/E_{in} = e^{-sT}$; that it can be approximated by

$$e^{-sT} = \prod_{i=1}^{m} \frac{1 - 2S\tau_i\xi_i + \tau_i^2S^2}{1 + 2S\tau_i\xi_i + \tau_i^2S^2}$$



Dr. F. S. Atchison, Technical Director, NOL-C, welcomes the Western Simulation Council Meeting at Corona, Calif.



and that the Bode diagram will be a constant amplitude and a phase shift that increases linearly with frequency.

Norm said that a tape recorder was excellent for the purpose, provided there was no d-c drift. Or a transmission line terminated in its characteristic impedance would give the theoretically correct transfer-function, but who knows how to simulate accurately a transmission line? Even a close approximation will "gobble up tons of equipment."

Norm explained $\tau\omega$ for any system is a constant, and its value is a measure of how well the delay produced by the system will approach real "dead time."

Otis asked about the tolerable error in determining $\tau\omega$; how do you decide when your approximation of pure time-delay has "gone sour"?

Norm answered that they used 1% change in amplitude and 1% nonlinearity in the phase-shift vs. frequency relationship as criteria. This seems reasonable for analog- computer work.

Jerry Jacobs (Hughes Aircraft, Culver City, Calif.) suggested that some might be confused by Norm's saying that $\tau\omega$ is a constant for any given system.

Norm explained that ω is the *maximum* angular frequency which still produces constant amplitude and linear phase shift, and that τ is the corresponding delay in seconds. Since $\omega\tau$ is constant for any delay-circuit configuration one can obtain longer delay at the price of high-frequency performance or vice-versa. There is, however, a maximum value of $\omega\tau$ beyond which the response of a given delay circuit will no longer approximate pure time-delay.

Leonard Nalley (Firestone Tire and Rubber Company, Los Angeles, Calif.) wanted to know how Norm measured phase to 1%. Norm replied that he didn't, he calculated it from the transfer function.*

Leon Levine (Hughes Aircraft, Culver City, Calif.) then explained a "sum and difference" method of measuring small angles using three amplifiers, three meters, and simple trigonometric identities.

Nalley said there was a description of a practical phase meter in *Geophysics* by a Stanolind Gas and Oil engineer, about 1944.

Otis said that the GEDA Application Report No. 2 (see Information) was the best he had seen. They indicate a maximum phase shift of 7.44 radians with an error of 0.021 radians, together with a transient-free variation of τ while operating.

McLeod asked Seferian why he was so anxious to get away from tape recorders. Seferian answered that he would like to have one at home, but that he thought use of tape would introduce extraneous problems in an analog-computer installation.

Otis asked whether anyone knew anything about Audio Instruments' tape-delay units. No response.

Norm said the tape problem would be simple if Ampex would cooperate. He says Ampex has the wow and flutter problem licked with their "Speedlock" and their FM system. Trouble is they can only take input of 1½ volts rms, and give the same output. If they would chopper-stabilize their output amplifier and increase the gain, "it should do it."

McLeod wanted to know why one could not install a jack after the Ampex detector and use the chopper-stabilized computer amplifiers. Norm said he didn't know the circuit well enough to answer, but several comments from the group indicated that the detector output was possibly near the noise-level of the computer amplifiers.

Hans Meissinger (Hughes Aircraft) asked if anyone had used a rotary switch with capacitors. Otis said he had started to try it with 100 capacitors, but had not completed the experiment because tape was simpler and good enough for their requirements.

McLeod mentioned the mechanical analog of the system which he understands Dr. Cowley at Shell Development in Emeryville is using. It consists of some 300 pins on the periphery of a drum which are positioned by the input signal and subsequently "read" as the drum revolves. (See "*Information*" for what is apparently a commercially available gadget like this.)

At this point the discussion was cut off to give us time for a tour through the facility of NOL.

Tour of NOL

The NOL Simulation and Computer Laboratory was of course of particular interest. They have Reeves, Electronic Associates, and Goodyear equipment for a total of some 210 operational amplifiers, together with the usual accessory equipment, including a three-axis flight table. This table is driven by fluid magnetic clutches which can be operated in conjunction with a target simulator having three degrees of linear freedom to give target elevation, azimuth, and range closure.

*See Lee Cahn on the subject in "*Information*."

Information (Without Theory)

Readers interested in the activities of the Industrial Analysis and Control Council, sporadically reported in these columns, may be interested to know that something is planned to quell the oft-repeated plaint "But we don't know enough about the process" to effectively use computers in the plant.

A three-cornered program is being organized which will be sponsored by a publisher (Instruments Publishing Company), a computer company, and a progressive processor with control problems. The sponsors will contribute $5,000 cash each, plus necessary equipment and services to support a one-year project to determine just what can be accomplished by putting an analog computer in the plant and connecting it to the process (analyzing all control and process situations).

Ten thousand dollars, the computer equipment, and an engineer with process control and analog computer experience are ready to go. The plant with a process, $5000, control problems, and an ability and interest in cooperating has not been selected yet. Any interest? Write your *Simulation Council Newsletter* Editor for details.

★ ★ ★

We have a communication from Milt Warshawsky via Charlie Morrill concerning our first story under PIECES. Milt says in part, "I'm a little disappointed at the absence of reference to my main theme, viz., the need for a specialized computer group and the slap I took at the manufacturers who imply otherwise. I'll admit that the subject is controversial, but I took my stand and think it should be reported." We give you Milt's remark not only because we are interested in the point per se, but because we think that whereas saying what we believe (and giving those who do not agree a chance to do the same) is not only a good principle of democracy, it is a vital necessity in

the Simulation Councils if we are to serve our purpose.

During the discussion of "time delay (reported under PIECES) the subject of how to measure small phase shifts came up. We give you some remarks on the subject as reported in the Simulation Council Newsletter of April, 1953:

"Lee Cahn stated that there are two ways of measuring small phase shifts, one of which is simply to increase the frequency until you get a phase shift that can be measured, because no matter how complex a network or transfer function may be, phase shift is nearly always a linear function of frequency up to 5 or 10 degrees. The other way is to set up a three-amplifier oscillator, such as that mentioned by Don Leggett, wherein the amount of feedback around one of the integrators to prevent the function's diverging is a measure of the phase lag."

We also promised you some references on the subject of time delay. They are as follows:

GEDA Application Report No. 2, by J. A. Rudolph, dated 15 June 1955, and the references given in that report:

C. D. Morrill, "A Sub-Audio Time Delay Circuit," *Trans, IRE, PGEC*, Vol. 3, pp. 45-49; June 1954.

W. J. Cunningham. "Time-Delay Networks for an Analog Computer," *Trans. IRE, PGEC*, Vol. 3. pp. 16-18; December 1954.

C. H. Single and G. S. Stubbs, "Transport Delay Simulation Circuits," Westinghouse Electric Corp., Atomic Power Division; Report WAPD-T-38.

C. H. Single and G. S. Stubbs, Supplement to the preceding reference.

And, finally, we mentioned a commercially available mechanical time delay. It is manufactured by Pratt & Whitney Division of Niles-Bement-Pond Company, West Hartford 1, Connecticut, and is described as a "Proportional Synchronizer" which stores a function in its "memory," which can be read out later to control a process.

Thots (To Think About)

As all of you may know, the Simulation Councils are continually faced with, and free discussion is sometimes inhibited by, a fear of divulging "proprietary information." For this reason we would like to quote, for all to consider, some of David Sarnoff's remarks on the subject of the "Stimulus of Competition" as taken from the article "New Developments in Electronics" in *Electrical Engineering* for March of this year:

"You may wonder what philosophy prompts me to reveal these new developments publicly while they are still in the experimental stage. Why do we not wait until they have been completed as commercial products? My answer is simple. Competition can be as stimulating in research as in manufacturing and merchandising. As members of a profession deeply concerned with scientific research and pioneering development, you are well aware that the number of people willing to risk their money in research and pioneering is very small compared with those who are ready to risk their capital in established enterprises operating profitably.

"In television and in other instances—where the information is not "classified" and does not involve our national security—RCA has continually made progress reports and released information that enabled others not only to catch up but at times even to move ahead of us. We welcome competition. It spurs our own activities and increases the possibilities for earlier achievement of desired results.

"Whether we succeed in completing an invention before others whom we stimulate to work along similar lines is not as important as it is to bring a new product or a new service into existence and use. In helping industry to grow and prosper, we believe that we contribute to the public benefit and in the long run, our own as well. If an organization is to progress, it must not stand in fear of obsolescence or competition."

As the Indian sending smoke signals said when he saw the mushroom cloud of an atomic blast: "I wish I'd said that!"

Computer Events

other events on page 1304

Association for Computing Machinery
Dates: 14-16 September 1955
Place: Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, Penna.
Subject: Annual General Meeting.
Contact: Sidney Kaplan, R. C. A. Computing Systems Engineering, Building 13-2, Camden 2, New Jersey.

Eastern Simulation Council
Date: 19 September 1955
Time: 1:30 P.M.
Place: Glenn L. Martin Company, Baltimore, Md.
Subject: "Computer Checking Procedures".

Western Simulation Council
Date: Thursday, 10 November 1955
Place: Beckman Instrument Co., Fullerton, Calif.
Subject: "Simulation with a Human in the System"

Fourth Annual Louisiana Polytechnic Institute Instruments Conference
Dates: 3-4 November 1955
Place: Ruston, Louisiana. Contact: School of Engineering, Louisiana Polytechnic Institute, Ruston, La.

Eastern Joint Computer Conference
Dates: 7-9 November 1955
Place: Hotel Statler, Boston, Mass.
Subject: "Computers in Business and Industrial Systems". Chairman of the program committee, Dr. I. Travis, Burroughs Corp., Paoli, Penna.

Second Computer Clinic
Dates: 15-17 November 1955
Place: Navy Pier, Chicago, Ill.
Feature: Six 2-hour demonstrations and lectures on various computers. Fee is $5.00. For registration: 2nd Automation Exposition, 845 Ridge Ave., Pittsburgh 12, Penna.

National Simulation Conference
Dates: 19-21 January 1956
Place: Dallas, Texas
It is expected that most of the papers will fall into the analog computer category, but papers on the use of digital computers in simulation will be strongly encouraged. Deadline for 100-word abstracts and 500-word summaries is September 10. Contact: J. R. Forester, 2104 Huntington, Arlington, Texas.

Western Joint Computer Conference
Dates: 8-10 February 1956
Place: San Francisco, Calif. Contact: Byron J. Bennett, chairman of the technical program committee, Stanford Research Institute, Stanford, California.

Instrumentation of a NATURAL-GAS PIPELINE

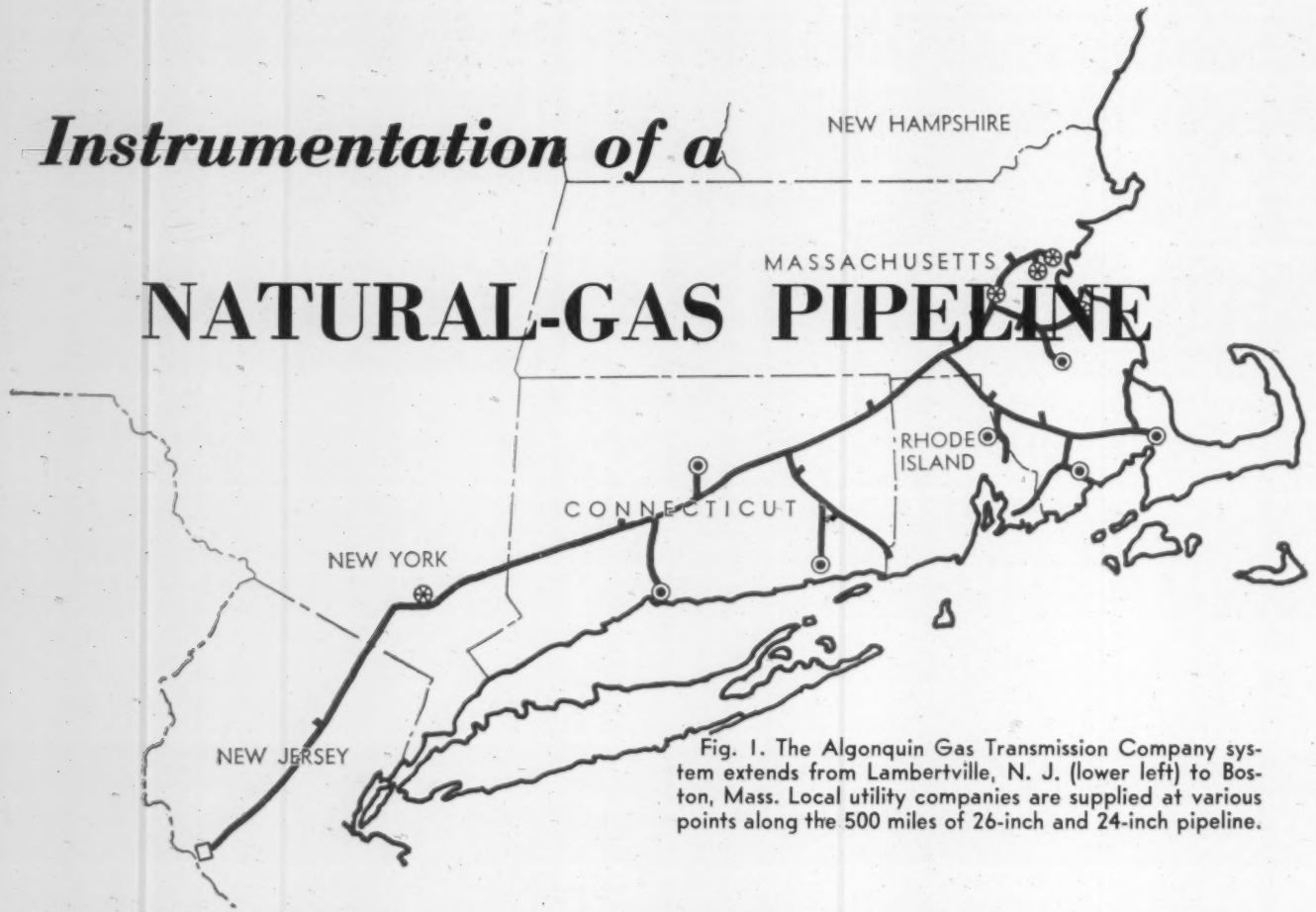


Fig. 1. The Algonquin Gas Transmission Company system extends from Lambertville, N. J. (lower left) to Boston, Mass. Local utility companies are supplied at various points along the 500 miles of 26-inch and 24-inch pipeline.

NATURAL GAS is transported from the well or production area to the distribution area by pipeline, operated by the gas transmission company. Distribution companies, in turn, supply customers. To meet the varying demands of customers, a gas transmission company must measure and adjust pressures and flows at various portions of their system. This can become a problem of tremendous scope. Instrumentation has done much to ease the task of the pipeline dispatcher and measurement groups responsible for efficient operation of a natural-gas pipeline. To illustrate this, let us consider a typical example—New England's newest pipeline, owned and operated by Algonquin Gas Transmission Company.

The Algonquin System

Texas Eastern Gas Transmission Company, with their "Big-inch and Little-inch Lines," supply gas to Algonquin. They connect to the Algonquin system at Lambertville, New Jersey (Fig. 1). The Algonquin high-pressure line crosses beneath the broad Hudson River at Peekskill, New York, crosses Connecticut with a 26-inch line to Hartford, goes on to Wellesley, Massachusetts with a 24-inch line, and to Boston with an intermediate-pressure 26- and 24-inch line.

Laterals extend from the main lines to communities throughout Connecticut, Massachusetts and Rhode Island, as shown in Fig. 1. These laterals supply gas to local utility companies at various points along the pipeline.

Local utility companies receive their gas at "city gate stations" (metering and regulating stations); it is at these points that a large percentage of the instrumentation of a pipeline is installed. These metering stations house the pressure-reducing equipment and the billing meters by which the utility is charged for the amount of gas taken from the pipeline. At many of these metering points Algonquin has installed telemetering and remote control equipment so that the dispatcher in the Boston headquarters of the company has complete information on, and supervision over, his entire transmission system.

Metering (City Gate) Stations

The metering stations are generally two- or three-run stations. This arrangement provides maximum measurement accuracy over a wide flow range because one orifice-meter run handles the entire flow under most conditions—that is, until flows build up to a point where the capacity of the run is exceeded. When this occurs, a differential limit controller opens and allows the second run to carry a portion of the load, thus bringing the amount of gas carried by either pipe into the range of the instruments.

Most of the stations are two-stage pressure-reducing stations; the first regulator cuts the pressure to an intermediate value from its full transmission-line pressure; the second drops it to the pressure which the local utility has determined to be best for its particular distribution system. Pressure-reducing equipment at the Wellesley regulator station is shown in Fig. 2.

Billing Meters

The billing meters are the "cash registers" of the transmission system. These are the recording flowmeters which measure the amount of gas used by the utility company. Most of these companies have contracts on a penalty demand basis, whereby the use of an amount of gas in ex-

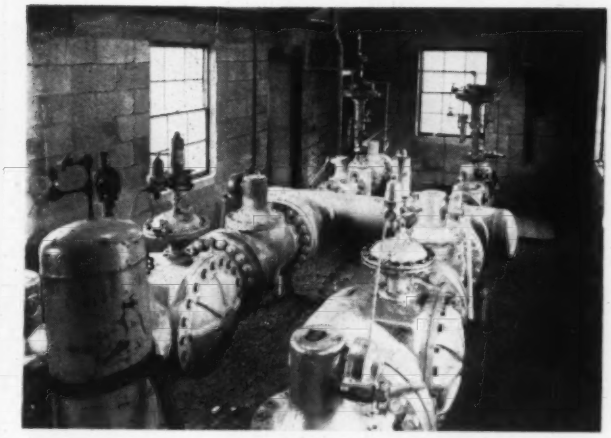


Fig. 2. Typical pressure-regulating station is this one featuring 2-stage pressure-reduction. Differential pressure (flow) in the two runs and the static pressure of the gas are telemetered to the dispatching office in Boston, Mass. The three variables are transmitted over a single leased circuit by use of a Bristol time-multiplex transmitter, which sends the three signals sequentially over the single circuit.

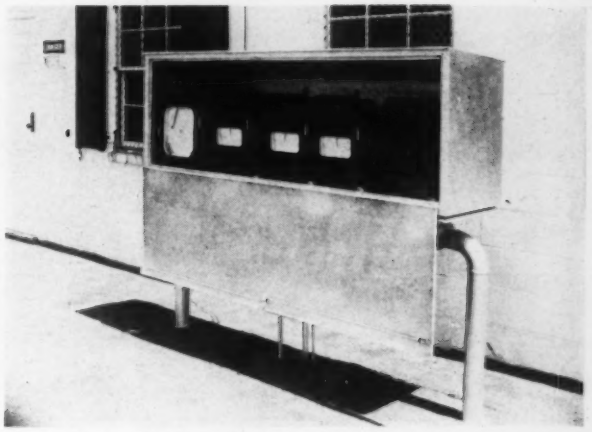


Fig. 3. Three telemeter transmitters (center), one multiplex transmitter (right) and remote-control recorder (left) are mounted outside the regulating station. The Multiplex Transmitter receives the three telemeter transmitter signals and sends them sequentially to the dispatcher at Boston (see Fig. 4). Remote controller at left permits control of the station from the dispatcher's office at Boston.

The Algonquin Transmission Co. pipeline is New England's newest. This survey of the system shows how a combination of continuous-recording telemetering and selective-calling telemetering is used for optimum monitoring and control of the 500-mile system from the dispatcher's panel at Boston.

WALTER E. RUFLETH
The Bristol Company

cess of that contracted for must be paid for at a rate considerably higher than that normally charged. The chart records are collected daily and the flows are totalized with the aid of a McGaughy Integrator (Rockwell Integrator). The chart is placed on the turntable of this instrument and rotated slowly. While it is rotating, two styli are used by an operator to trace the records of the differential and static pressures on the chart. The movements of these arms are translated into the total volume passing through the meter run.

System Telemetering

Although the billing meters are the cash registers of the company, and can be used in determining peak loads, operating pressures, number of compressors to put into operation, and type of regulation required, they contribute little to the solution of immediate dispatching problems. To assist in day-by-day operations, Algonquin depends on system-wide telemetering to their dispatching headquarters in Boston. The telemetering system is unique in its use of both continuously-recording telemetering and selective-calling techniques. This combination was felt necessary to supervise adequately the transmission system which stretches over 500 miles of pipeline, and yet has one-third of its total load concentrated in the metropolitan Boston area.

Because of Boston loads it was decided to use continuously-recording telemetering instruments to cover the Boston area, and selectively-called telemeter indicators for the outlying stations. There are four stations in the Boston area, which telemeter information on differential pressures and line pressure back to the dispatching office. A typical regulating station is shown in Fig. 2; the Metameter telemeter transmitters are shown in Fig. 3, mounted outside the station in a metal housing. The measurements taken at the regulator station are multiplexed by the Bristol Time Multiplex transmitter (shown at the extreme right in Fig. 3) and then sent sequentially over one leased telephone circuit to the dispatcher's panel in the company's Boston office on historic Fanueil Hall Square. This panel is shown in Fig. 4. There, a Multiplex receiver "unscrambles" the incoming signals and directs them to their proper recording receivers.

Selective Calling

To keep tabs on the outlying metering-regulating stations, selective calling equipment with multiplexing has been installed at eight stations in Connecticut, Massachusetts, and Rhode Island.

At each of these stations, measurements are taken by Metameter telemeter transmitters of differential pressures (flows) in the two runs; upstream pressure also is measured. These measurements are fed to a Time-Multiplex transmitter, and when the code assigned to the station is dialed by the dispatcher, a telephone-company selector switch is energized and all three measurements are sent sequentially over a single leased circuit to the Multiplex receiver on the dispatching panel at Boston. (The selector at Wellesley is shown in Fig. 5.) The indicators at Boston continue to show the measurements until the dispatcher clears the circuit and dials a new code number.

These outlying stations are normally called once an hour, which is usually sufficient to enable the dispatcher to maintain complete knowledge of conditions all along the pipeline. During periods when operations are critical, the indicators may be dialed to a certain station and kept connected. In this way any changes in conditions will be immediately apparent, and corrective action can be begun quickly. Using this technique a number of cases of freeze-

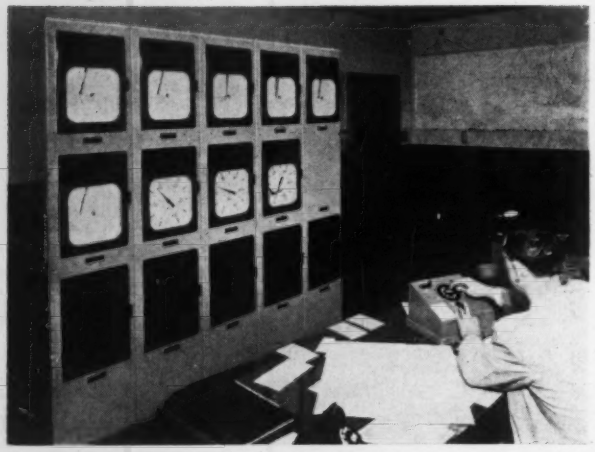


Fig. 4. Instrument panel board at Boston dispatching office. Dispatcher is dialing the code number assigned to one of the outlying transmission stations. When transmitter is connected to the multiplex transmitter at the remote station, the three readings (flow and static) will be indicated on the indicators in the center row of instruments on the board. Bottom row are multiplex receivers which segregate incoming signals and direct them to the proper receivers. Indicators will hold reading until dispatcher clears the wire and dials another station.

up in the line have been detected and remedied before any damage could occur.

Proportioning of Load

One of the major uses of the telemetering system lies in the shifting of blocks of gas from one customer to another. If one utility calls for an additional five million cubic feet of gas, the dispatcher can determine quickly whether it is available in the line without increasing his take from his supplier, Texas Eastern. If it is, sales go up without increased costs. (Algonquin Gas also is set up on a penalty rate contract, similar to its customers, so the use of over-contract quantities of gas can be expensive.) Naturally, it is to Algonquin's benefit to sell all the gas it can while staying within its MDQ (maximum daily quota). Without telemetering equipment, the company would have to allow a large reserve in its lines to take care of unexpected demands. With the system it can sell up to its limit, and still be able to switch loads as required. Some of Algonquin's customers are on a "dump load" basis, and can use gas whenever it is available for a short period of time at a reduced rate.

Remote Control

Instruments which allow the dispatcher to control remotely the flow of gas through any of the telemetering stations have been installed. The control signals are carried over the same circuits which carry the telemetered signals back to the dispatch office. (One can be seen at the far left in Fig. 3.) They will see their most important use during emergencies, such as breaks or heavy leakage, to maintain pressures while lines are being repaired or to shut down the flow as required.

This control is to be operated through the same telephone-company dialing system that is used for telemetering. The dispatcher will dial one code number to raise the flow values, and another to lower it. The apparatus has a limiting device to avoid any disastrous effects from incorrect dialing. The indicators showing the conditions

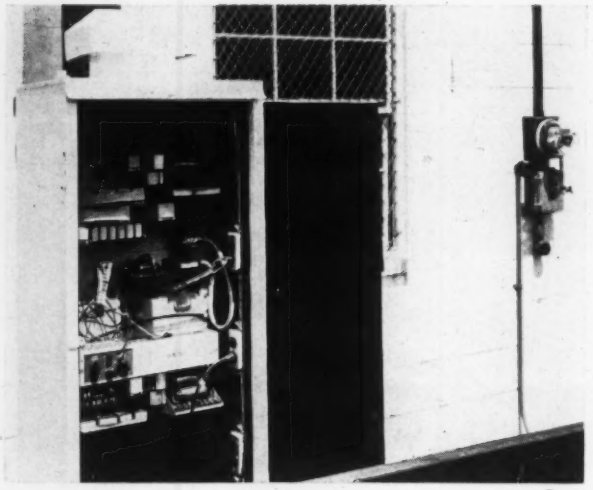


Fig. 5. Telephone-company selector equipment at a typical station. When Boston dispatcher dials the code for this station, the variables being measured here are telemetered to Boston.

at the outlying station involved can be left in the circuit while the control dialing is taking place, thus allowing the dispatcher to see exactly what takes place during the control operation.

There is another continuously recording telemeter circuit at Peekskill, N. Y., where the pipeline crosses the Hudson river. This record of pressures, which is transmitted to the District Headquarters, enables the company to comply with requirements regarding the maximum pressures allowed in the pipeline crossing the state. Telemetering facilities are considered equal to a "manned" station.

Other Communication Facilities

In addition to the systems mentioned, other communication facilities include (1) a leased telephone circuit to the supply point at Lambertville, N. J., (2) a teletypewriter to the last telemetering dispatch station on Texas Eastern's transmission line at Eagle, Pa., (3) two-way mobile radio equipment for communication between the dispatcher and the service units and, of course, (4) telephone communication with all the distribution companies served. In addition, several distribution companies have set up supplementary Metameter telemeter receivers which operate through repeater relays from the Algonquin transmitter at the metering station which serves them. In this way the utility has a record of the pressures being maintained at its supply point. This record has been of help to Algonquin when troubles have developed between the times of hourly dialing of the station. The utility has called in to inform them of the upset, and the Boston dispatcher was able to take corrective action.

The telemetering system which Algonquin has installed has proved remarkably effective in predicting the total loads which are handled by the transmission system. A check on the accuracy of the values logged from both the selective calling stations and the records of the continuously recorded measurements show an average discrepancy of only ½ to 1½%, as compared with the billing meters. This is a good indication of the adequacy of the telemetering coverage.

Multiplexing

The basic reason for use of multiplexing in a telemetering system of this type is to reduce transmission-line

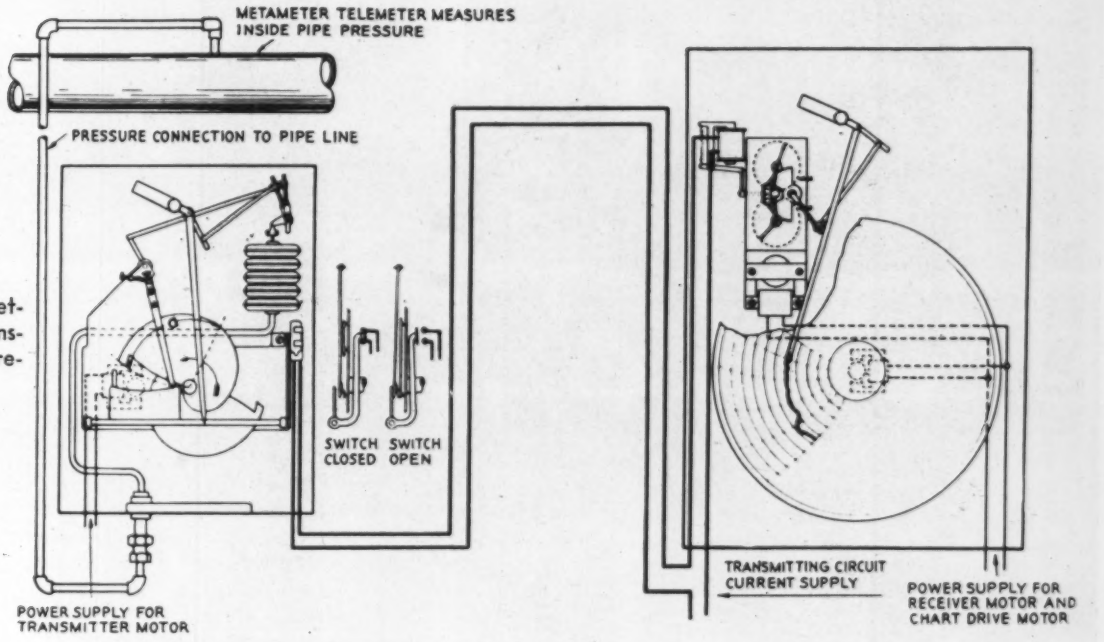

METAMETER TELEMETER MEASURES INSIDE PIPE PRESSURE
PRESSURE CONNECTION TO PIPE LINE
SWITCH CLOSED
SWITCH OPEN
POWER SUPPLY FOR TRANSMITTER MOTOR
TRANSMITTING CIRCUIT CURRENT SUPPLY
POWER SUPPLY FOR RECEIVER MOTOR AND CHART DRIVE MOTOR

Fig. 6. Metameter transmitter and receiver.

costs. Rental charges for telemetering transmission circuits are usually based on the type of line (i.e., telephone or telegraph), the quality of the circuit, and the number of signals that are being transmitted simultaneously on the line. Sometimes, when a line is used with carrier or multiple-channel equipment to transmit several signals simultaneously, the rent is the same as if separate lines were used for each signal.

The Time-Multiplex System depends on the synchronous operation of two 16-point selector switches, one located in the Multiplex Transmitter and the other in the Multiplex Receiver. These switches provide the sequential connection of the Metameter transmitters and their respective receivers to the transmission circuit. The transmission circuit carries only Metameter signals and the synchronizing signal of variable time duration.

When fewer than 15 Metameter Systems are used with the Multiplex equipment, the terminals are interconnected to permit some of the systems to be connected several times for each revolution of the scanning switch.

Synchronization of the transmitter and the receiver scanning switches normally is checked once per scanning cycle (16th point). The synchronizing signal differs from the measuring signals only by the time duration of the transmitted pulse. Sometimes, temporary fault can cause the scanning switches to get out of step. (Such a fault may be a power failure or an "open" in the transmission circuit.) The Multiplex System will synchronize itself after the fault is corrected. When the scanning switches are out of step, the Receiver scanning switch will stop when it reaches its synchronizing point; it will then remain stationary until the Transmitter switch reaches its synchronizing point and provides the signal to restart the Receiver scanning-switch mechanism.

Metameter Principle

The Metameter telemeter operates on the impulse-duration principle.* The signal impulse transmitted is a function of time (rather than an electrical quantity). The duration of the electrical impulse is proportional to the measured variable (pressure, flow, or temperature).

The Metameter telemeter transmitter samples the measured variable through a primary measuring device (Bourdon spring, differential meter body, temperature element, etc.) and opens and closes a switch accordingly. With a 5-second impulse-cycle system, the length of the signal transmitter will vary from 1 to 4 seconds (20% to 80% of the basic 5-second cycle). For example, if it is required to telemeter a pressure range of 0 to 100 psi, the length of the impulse will be 1 second at 0 psi, 2.5 seconds at 50 psi, and 4 seconds at 100 psi. The signal is repeated once every 5 seconds.

Fig. 6 shows a Metameter telemeter system for the transmission of pressure. As the cam rotates, driven by a constant-speed motor, the tip of the cam follower slides across the cam surface (not along the edge of the cam) and drops off the trailing edge. It is again picked up by the cam's leading edge. As this happens, a trip plate is moved in and out, opening and closing a mercury switch.

At the Metameter receiver, a relay or electro-magnet converts the transmitted impulse to a mechanical motion for positioning a recording pen or indicating pointer.

Advantages of Telemetering

Use of telemetering by gas transmission companies is increasing at a rapid rate as the benefits resulting from such systems become increasingly apparent. The systems have enabled pipeline operators to operate at higher profits, to make more efficient use of manpower, and to provide smoother, more satisfactory service to the ultimate consumer.

In general, instrumentation of pipelines has resulted in (1) the ability to shift gas from one area to another, (2) the ability to use gas out of "line storage" during short cold snaps without increasing the take from the supplier, which reduces the probability of penalty rate charges, (3) providing means for constantly watching conditions throughout the system, which allows detection of faults and operational difficulties before they become serious, and (4) promoting the feeling of confidence and assurance of continuity of service and control with both customer companies and regulatory bodies.

*See article "Pipeline Telemetering," by J. W. Peckham, *Instruments and Automation*, July, 1955, for details of Metameter transmitter and receiver.

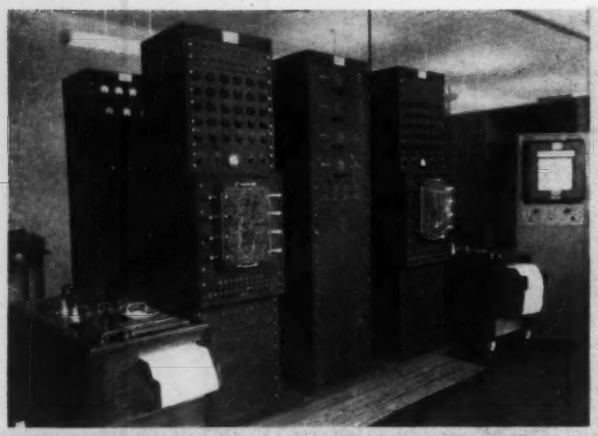


Fig. 5-1. Reeves electronic analog computer, or "REAC," which was used in the analysis.

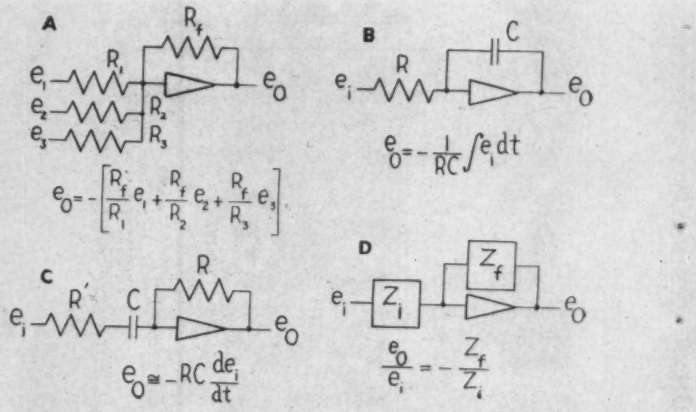


Fig. 5-2. Operational amplifier of computer (depicted by triangle) is converted into (A) summing amplifier, (B) integrator, (C) differentiator, or (D) any generalized circuit by appropriate input and feedback networks. Circuits A and B are provided on the computer.

Process Control Analysis

V

USE OF AN ANALOG COMPUTER

CLOSED-LOOP CONTROLLED-SYSTEM equations (developed in Chapter III) may be solved analytically (as shown in Chapter IV). If the order of the equation is three or higher, the labor involved in long-hand solutions becomes excessive. For these higher order systems it is advantageous to use some form of an automatic computer as a time-saving measure. This chapter is concerned with the use of an Electronic Analog Computer, which equipment lends itself to the rapid solution of differential equations. Fig. 5-1 shows the computer used to obtain the results included in this chapter.

The Computer

The four important components of the analog computer are (1) potentiometers, (2) integrating amplifiers, (3) summing amplifiers, and (4) inverting amplifiers.

1. *The potentiometer.* This is a voltage divider equipped with a calibrated adjustment. It is the component that provides for fractional multiplication. A voltage can be multiplied by any number between zero and unity. Analog computers use a comparatively large number of potentiometers.

2. *The operational amplifier.* This unit consists of a high-gain a-c amplifier and associated circuitry, as shown in Fig. 5-2. Some analog computers use d-c amplification. Numbers of amplifiers are provided in the analog computer.

The amplifier is represented by a triangle in Fig. 5-2. The associated circuitry comprises an input resistor (or network) and a feedback resistor or capacitor. When the amplifier gain is very large, the use of total feedback from amplifier output to its input (or summing point) makes the circuit behave like a near-perfect inverter, summing amplifier, integrator, or differentiator (depending on the associated circuitry). For example, use of one input resistor and one feedback resistor of the same value (commonly 1 megohm), produces a near-perfect sign changer in which the output is the exact negative of the input. Use of several input resistors (as in Fig. 5-2, A) and the 1-megohm feedback resistor produces a summing amplifier, as shown. Use of a feedback capacitor produces an integrator, as shown in Fig. 5-2, B. Use of the operational amplifier as a differentiator is shown in Fig. 5-2, C.

For convenience, the analog computer has available several operational amplifiers already wired for use as inverters, summers, and integrators, with several inputs available with values of 1, 4, and 10 as desired. That is, the summing amplifiers are made available with R_f/R_i ratios of 1, 4, and 10 (see Fig. 5-2, A) and integrators are made available with 1/RC values of 1, 4, and 10 (see Fig. 5-2, B). Multiplication or integration by other than these factors of 1, 4, and 10 must be done by use of the potentiometers in series with these inputs.

Integration, rather than differentiation, is used most extensively in analog computers because noise impulses are attenuated by integrators but amplified by differentiators. Hence the analog-computer solution to problems

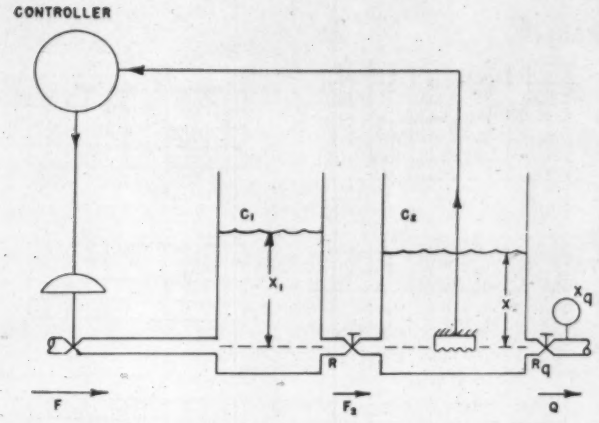


Fig. 5-3. Two-capacity liquid-level process with ideal (lagless) controller and lines.

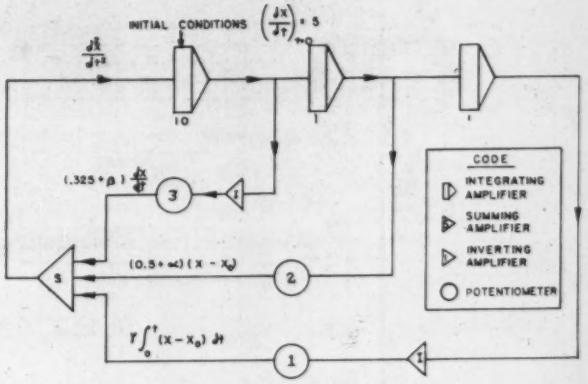


Fig. 5-4. Analog-computer diagram for analysis of the control problem of Fig. 5-3.

An analog computer can provide rapid solutions to the integro-differential equation for a closed-loop process-control system. Computer elements are described and a typical liquid-level problem is set up on the computer. Computer solutions to the control problem show the ease with which the individual effects of process and controller constants are analyzed.

MILLARD H. LAJOY
University of Minnesota
and
E. ALLEN BAILLIF
Seeger Refrigerator Co.

involves use of (1) potentiometers, (2) integrating amplifiers, (3) summing amplifiers, and (4) inverting amplifiers. The symbols for these basic elements are shown in Fig. 5-4.

Let us examine the general procedure for setting up an actual problem, and also some typical results.

Example Problem

Fig. 5-3 is a two-capacity liquid-level process with an ideal (lagless) controller. Let us assume a step change in output potential. The sudden upset provided by such a step change is a severe disturbance on the control system; a system proving satisfactory for this should be satisfactory in practice.

The system equation for a controller with proportional plus derivative plus integral control is:

$$J_2\frac{d^2x}{dt^2} + (J_1 + R_q\beta)\frac{dx}{dt} + (1 + R_q\alpha)(x-x_o) + R_q\gamma\int_o^t(x-x_o)\,dt = x_q-x_{qo} \qquad 5.1$$

The values of the process constants (chosen to yield the type of transient response encountered in process work) are:

$C_1 = 1$ cu ft/ft.
$C_2 = 2$ cu ft/ft.
$R_2 = \frac{1}{2}$ ft/cu ft/min.
$R_q = 2$ ft/cu ft/min.
$x_q-x_{qo} = +20$ ft = step disturbance.

x = level to be controlled.
x_o = initial level of x.

Inserting the numerical values for the process constants:

$$\frac{d^2x}{dt^2} + (3.25 + \beta)\frac{dx}{dt} + (0.5 + \alpha)(x-x_o) + \gamma\int_o^t(x-x_o)\,dt = 10 \qquad 5.2$$

Let us assume that the physical system represented by the equation is such that the values of the controller constants used are within the capabilities of the controller and final control element. The computer wiring diagram necessary to solve this equation is shown in Fig. 5-4.

Effect of Proportional Control

With the computer it is simple to examine the effect of any control response simply by setting the appropriate potentiometer. For example, by adjusting potentiometers 1 and 3, β and γ can be set to zero, and the effect of proportional control alone (α) can be investigated. The results obtained on the recorder chart for this condition are shown in Fig. 5-5.

The effect of an increase in the proportional response (α) is to decrease the steady-state error (offset) and increase the oscillation in the transient response. The relative amount of these effects, of course, depends on the value of that part of the coefficient of the $(x-x_o)$ term in equation 5.2 contributed by the process constants.

This type of computer does not give numerical answers.

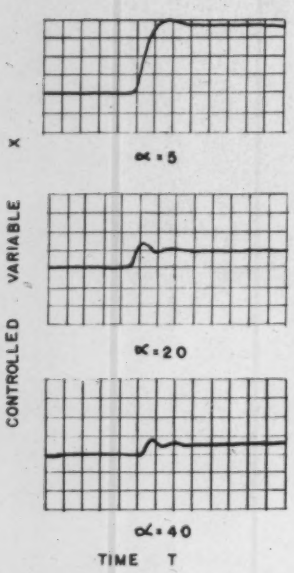


Fig. 5-5. Computer solution of control problem showing effect of proportional control alone. Increase in α decreases the offset, but increases transient oscillation.

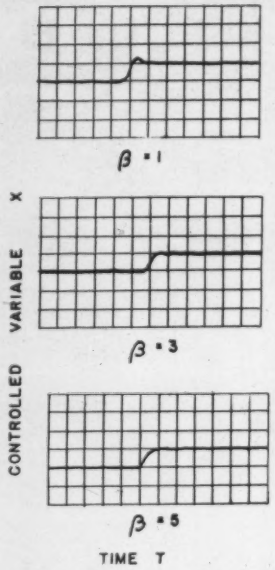


Fig. 5-6. Computer solution to control problem showing effect of adding derivative control to proportional controller. Offset remains the same, but overshoot is reduced as derivative control factor is increased.

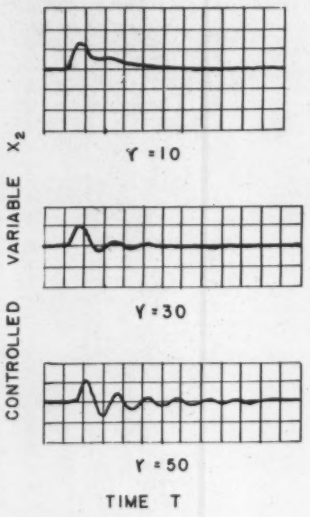


Fig. 5-7. Computer solution to control problem showing effect of integral control with constant proportional control. Integral control eliminates offset, but overshoot and oscillation result from high integral action.

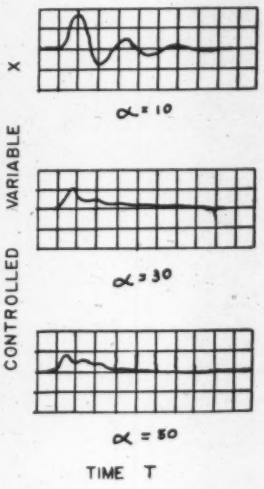


Fig. 5-8. Computer solution to control problem showing effect of proportional control added to constant integral action. Increase in α makes system more stable, but increases time to return to control point.

However, in analysis of automatic control systems we usually do not seek numerical answers, but rather the type of response or degree of stability obtainable.

Effect of Rate Response

Let us now consider the effect of adding rate response to the controller. This is done simply by adjusting potentiometer 3 in Fig. 5-4. The curves shown in Fig. 5-6 were obtained with a proportional-plus-rate controller on the same process. The integral control factor (γ) was zero and the proportional control factor (α) was 20 for the results shown.

Note that the value of the steady-state error is unchanged, but that the initial overshoot can be reduced. This is expected because rate control is sensitive to the rate of change of the controlled variable and applies a correction that leads the proportional control.

Effect of Integral Response

Let us now examine the effect of integral response with constant proportional response. For this example the rate control factor (β) was set to zero, and α was left at 20. The results are shown in Fig. 5-7.

The most important effect of the addition of reset response is seen to be that it reduces the steady-state error to zero—that is, it eventually returns the level to the desired control point. A slight increase in the value of γ tends to improve the quality of control by making the return to the set point more rapid. A further increase, however, results in excessive oscillation and, finally, instability. Note that the system without integral control is of the second order and can never be unstable if the coefficients are positive. However, the addition of the integral term transforms it into a third-order system which can be unstable if the value of γ is made too large.

Proportional Response with Constant Integral Response

Fig. 5-8 shows the effect of variations in the value of α when integral response is present. This series was run with the value of $\beta = 0$ and $\gamma = 20$.

Note the effect of an increase in α is to make the system more stable. This is just opposite to its effect when integral response is not used.

An interesting feature to be noted is the effect caused by high values of α. The benefit of the reset (integral) response is partially nullified, resulting in a long period of elapsed time before returning to the set point.

Equations 5.1 and 5.2 show that the process constants are directly additive to the controller constants in two of the coefficients. This emphasizes the fact that the design of the process is as important as that of the controller: for real advances in the field both must be considered together. A modification of the resistances R and the capacities C of a given process can produce the same results as the inclusion and adjustments of proportional and rate control factors α and β respectively. Thus, with ideal process design, simple controllers can do an effective job.

To be continued

Instrument Markets Abroad*

RICHARD RIMBACH

LAST fall the Business and Defense Services Administration, Department of Commerce, submitted a questionnaire to the U. S. Foreign Service in 39 countries. This questionnaire had two sections:

I. Scientific and Laboratory Equipment

II. Industrial and Process Instruments and Equipment

The first phase of this survey resulted from a letter dated July 28, 1954 from the Scientific Apparatus Makers Association to the Department of Commerce. According to SAMA, their interest is not confined to the domestic market, as their exports exceeded $40 million in 1953. On the other hand, the imports in this field is $10 million. In the request the Association expressed interest in receiving facts and figures as to the character and extent of production and distribution of foreign competitors, but more particularly as to the possibility for doubling sales of scientific equipment in the world markets generally.

For the guidance of the U. S. Foreign Service reporting office the following broad groups of products and commodity numbers in parenthesis were listed in the questionnaire:

1) Drafting, Engineering and Surveying Instruments (916010-916029)
2) Optical Instruments (914750-914998) (919060-919066)
3) Flight, Navigational and Meteorological, Geological and Nuclear Radiation Detection Devices (794820, 916050, 919010, 766995) (708410)
4) Horological Instruments and Timers (957000-959-198)
5) Laboratory Apparatus, Equipment, Furniture and Supplies for analysis, inspection and testing of chemical and physical properties of materials and products (529100, 533700, 949610, 919068-919080)

*Based on a report from the Department of Commerce.

The second section of the questionnaire was sponsored by SAMA—Industrial Instruments and Recorder-Controller Sections. This part of the survey is made up of three related groups, and the products and commodity numbers in parenthesis listed were:

Electrical Measuring Instruments

1) Integrating meters (703500, 703620, 703700) (Watt-hour and demand, indicating and recording)
2) Test equipment (properties & performance) (703825, 703850)

Mechanical Measuring Instruments

1) Gas & Liquid Meters (774100, 774200)
2) Process Measuring N.E.C. (766970, 766990, 766993, 792605, 794825)

Automatic Control Devices

1) Regulating Valves (774490)
2) Temperature Controls (766950)
3) Industrial & Process, Control Mechanisms (702300, 702320, 703110) (704810, 704820, 704850) (electric, electronic, hydraulic, mechanical, pneumatic)

The United States is the outstanding producer of these products. At present we are exporting $65 million annually to over 100 countries, while we import only $2 million of such products.

To date, reports have been made by the American Embassies in two countries: Australia and Egypt, and the information extracted from these is tabulated below.

Table I. Scientific and Laboratory Instruments and Equipment

	Australia*		Egypt*	
	Annual Imports 1953-54	*From USA* 1953	*Annual Imports* 1953	*From USA* 1953
Drafting, Engineering and Surveying Instruments	$ 548,113	$ 20,807	$ 351,192	$ 4,642
Optical Instruments	1,224,931	$ 81,883	$ 610,692	$ 8,036
Flight Navigational and Meteorological, Geological and Nuclear Radiation Detection Devices	1,140,300	$ 92,608		$ 1,903
Horological Instruments and Timers	5,515,969	$ 15,930	$2,435,142	$ 1,296
Laboratory Apparatus, Equipment, Furniture and Supplies for analysis, inspection and testing of chemical and physical properties of materials and products	1,250,378	$ 70,518	$ 240,233	$ 18,354

* conversion to U. S. dollars made using $2.25 per Australian Pound and $2.87 per Egyptian Pound

Table II. Industrial and Process Instruments and Equipment

	Australia		Egypt	
	Annual Imports 1953-54	*From USA* 1953	*Annual Imports* 1953	*From USA* 1953
Electrical Measuring Instruments	$ 846,190	$232,855	$448,339	$ 6,974
Mechanical Measuring Instruments	$9,069,891	$662,024	$738,657	$49,500
Automatic Control Devices	$4,543,125	$764,155		$64,577

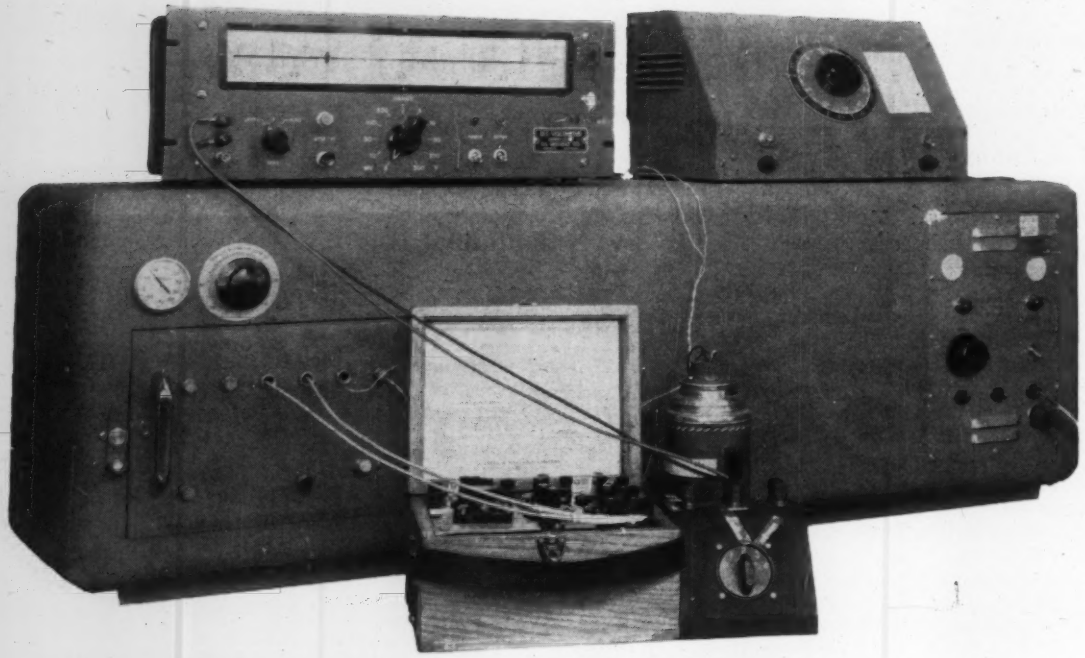


Fig. 1. Setup for accurate calibration of temperature-sensitive probes. Probe is in Statham test chamber, which contains a thermocouple of NBS-certified wire (standard TC wire may have errors up to 3° from standard tabular values). At upper right is a precision temperature controller[6] for controlling the test chamber. At upper left is a potentiometer for measurement of chamber temperature. This is a Moseley Model 520 self-balancing potentiometer-voltmeter (range: 3 mv to 300 v dc). Icebath reference for TC is shown to right of L&N Model 5305 Resistance Bridge (for measuring bridge resistance); external 22.5-volt battery is used for bridge excitation.

Telemetered Temperatures

FLIGHT-TESTING of missiles and aircraft involves measurement of free air, compartment, and component temperatures. This information often is telemetered to ground to prevent the loss of data in event of loss of aircraft or missile.

The complexity of the temperature-measurement system depends on the sensitive element selected. With the FM/FM and PWM telemetering systems in use at most Government- and Contractor-operated facilities, a zero- to five-volt d-c signal is required to modulate the FM subcarrier oscillators. Obtaining a five-volt d-c signal from a thermocouple or resistance element of standard alloys requires amplification (at normal temperature ranges these elements supply from 10 to 250 millivolts, respectively). Thus, either a separate amplifier for each temperature channel, or sequential sampling techniques must be used. For these reasons, design studies were made to develop a system capable of direct operation of the subcarrier system of a telemetering system without much amplifier or other support equipment.

Selection of Resistance Element

Thermopiles, semiconductor elements, and various alloys were investigated to obtain a zero- to five-volt signal, without amplification. Limitations in temperature range, linearity, hysteresis, repeatability and accuracy eliminated all but one resistance-alloy element.

An alloy resistance wire of high volume-resistivity is required in a temperature probe of small thermal mass and high resistance. Conventional alloy wires used in pyrometry did not possess either high volume-resistivity or the high resistivity-temperature coefficient required in combination. One alloy wire was found to be satisfactory; manufactured by Wilbur B. Driver Company, it has the trade name "Balco." This resistance element has a high, yet constant temperature-coefficient. Balco is an alloy of 70% nickel and 30% iron; it has a temperature coefficient comparable to that of commercially pure nickel, and a resistivity of 120 ohms per circular mil foot at 20°C (68°F), which is twice that of nickel. This allows a high-resistance probe of small thermal mass.

The slope of Balco temperature-resistance curve is almost straight from 20 to 700°C (68-1292°F), which is about twice the effective range of pure nickel; typical linearity is indicated in Fig. 2, which is the linearity of an Arnoux Corp. "Series 1000" probe between minus 50 and plus 450°F.

Bridge Circuit

The circuitry shown in Fig. 4 indicates that a modified Wheatstone half-bridge is used, with the probe forming the only active leg. The conventional bridge circuit with two active legs (catacorner to double the sensitivity) was not employed for four reasons. First, adequate sensitivity is secured with only one active leg. Secondly, use of a dual resistive probe decreases response time (due to increased mass) and adds to the complexity of wiring required. Third, and possibly most important, use of the half-bridge circuitry eliminates power-consuming dummy legs. Fourth, increased reliability is obtained.

Another important reason for using a single probe in a half-bridge is that all outputs of the several channels can have one side grounded. This is especially important in telemetering applications where all the outputs have to work against ground. This is accomplished by grounding the center tap (negative signal lead for all channels) of the dual power supply shown in Fig. 4.

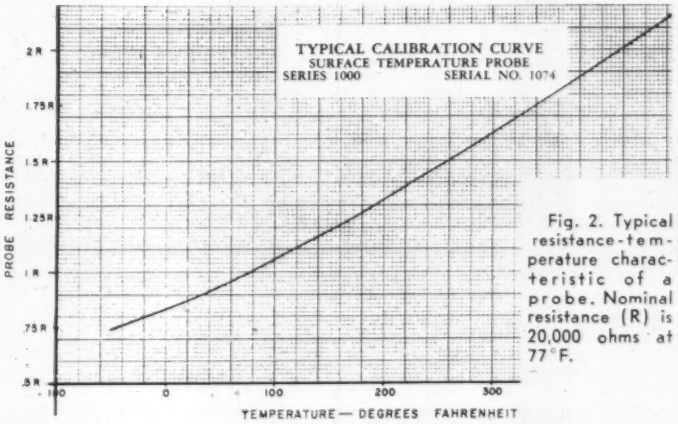


Fig. 2. Typical resistance-temperature characteristic of a probe. Nominal resistance (R) is 20,000 ohms at 77°F.

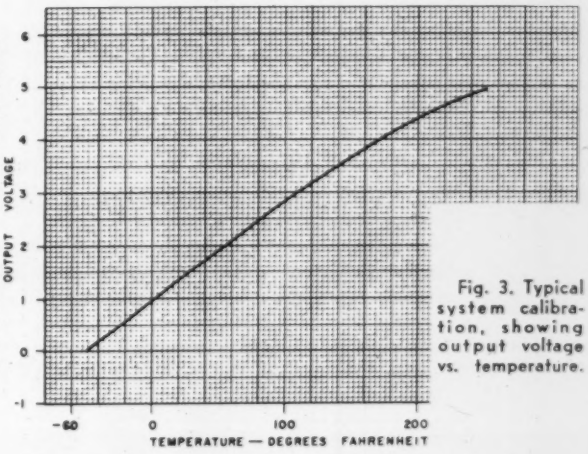


Fig. 3. Typical system calibration, showing output voltage vs. temperature.

A. B. KAUFMAN
Arnoux Corp.

Required: A temperature measuring system with 5-volt d-c output for temperature span of 250° F—with no amplification—for use in telemetering, aircraft, etc.

Solution: Balco-wire resistive probe in a half-bridge modified Wheatstone circuit.

Probe, bridge, calibration, and response are discussed in detail.

Probe Design

The available output voltage, with fixed load and excitation voltage, is a function of the temperature-resistance coefficient of the probe. The load consists of the high input-impedance of the subcarrier oscillators (of the order of 500,000 ohms); therefore, impedance matching of bridge to load is not required because power transfer is no problem. In order to obtain adequate output voltage, either the resistance probe must have a high coefficient of temperature-resistivity, high excitation-voltage, or both.

Utilizing nickel or Balco wire gives the highest available temperature-resistance coefficient. This in itself is not enough. A high enough resistance value must be obtained which, with sufficiently high bridge voltage to secure the desired output, does not generate excessive I^2R heat in the probe. The bridge d-c excitation voltage is about 50 to 55 volts; at balance, about 25-27 volts is across the probe. Probe resistances are nominally 20,000 ohms at 77°F. At −50°F this may fall to approximately 15,000 ohms—and at this value excessive I^2R heating must not occur because if the probe is self-heating, accuracy is impaired. The Arnoux probes show a resistance change equivalent to less than 1°F under bridge excitation, in free air, and this is swamped out when the probe is attached to any reasonable mass, or thermal sink.

The design of the probes involves much more than the winding of wire on a bobbin. High-temperature operation requires use of Teflon-insulated wire, and soldering or welding techniques to withstand vibration and high ambient temperatures. Bonding material must have high thermal-transfer and non-hygroscopic characteristics to allow fast response and to prevent failure under MIL-specification humidity testing. As some variation exists between different spools of Balco wire, probes are not directly interchangeable without reset of the calibration controls. However, as each channel may be set up for different temperature ranges, calibration of the system would be required in any event.

Response Time

Response-time tests on Arnoux "Series 2,000 and 3,000" probes indicate the following response times (in seconds) for 63% response to a step change in temperature:

Immersion	Heat Conductivity	"Arnoux 2000" Response Time	"Arnoux 3000" Response Time
Air (static)	(0°C) 0.000057	53	92
Liquid (water)	(0°C) 0.0012	8.9	5.2
Metal (copper)	(18°C) 0.918	0.25 (est.)	0.1 (est.)

The information indicates that the speed of response depends on several factors other than probe design. These include the velocity of gas or liquid flow, thermal coefficient of the environment (gas, metal, etc.), and the relative mass of the thermal sink or source. It is obvious that response time of a temperature-measuring system must be correlated to the operational use of the temperature probes. Relative response can be determined if the same test configuration is used; however, this can lead

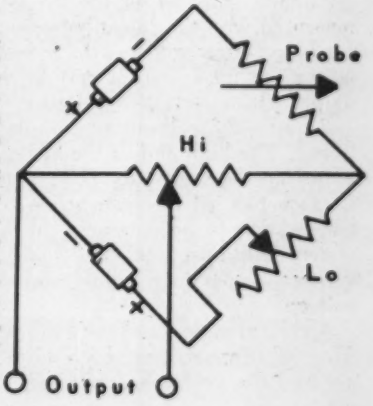


Fig. 4. Basic circuitry. Probe is the only active leg in the half-bridge modified Wheatstone-type circuit. Common point of the two voltage supplies shown can be grounded. Advantages of this half-bridge circuit are (1) adequate sensitivity, (2) fast response because only one probe is used, (3) power-consuming legs are eliminated, (4) high reliability, and (5) output is referenced to ground.

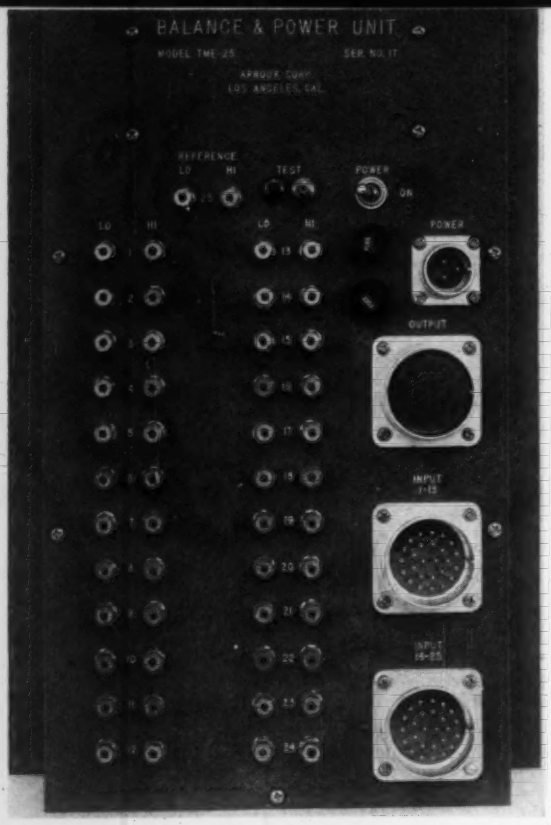


Fig. 5. Commercial version of TME system is complete; requires only probes for the 24 recording channels and 1 calibration channel.

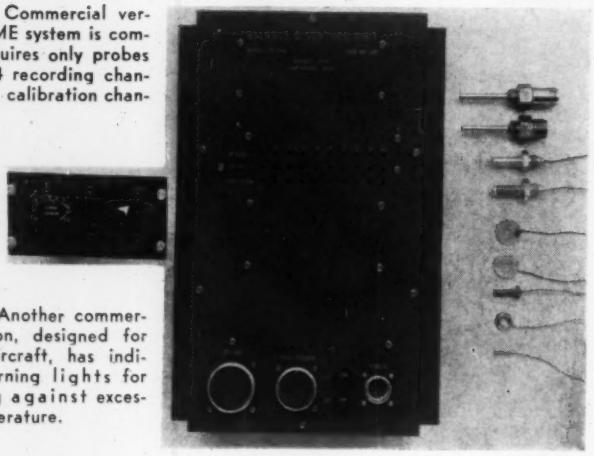


Fig. 6. Another commercial version, designed for piloted aircraft, has indicating warning lights for monitoring against excessive temperature.

to an erroneous decision as to proper probe if all factors are not considered.

Typical System

Typical of the design of a complete system is the TME Arnoux system. Basic wiring circuitry is shown in Fig. 4: Fig. 5 shows the one piece of support equipment required for 24 recording channels and 1 calibration channel.

Excitation voltage for the 24 bridges is supplied by a closely regulated, magnetic-amplifier-type power supply which furnishes two separate d-c outputs. Each output acts as a separate leg of the bridge for all channels. No cross-modulation results from this common connection of all bridges because the power supply is effectively a zero-impedance element in the circuitry. The temperature probe is the third leg of the bridge; the fourth leg locates the range adjustment potentiometer (the LO Adjust). A sensitivity potentiometer (the HI adjust) is connected across the output of the bridge.

Adjusting and Calibrating System

When adjusting the system for desired voltage output and temperature range, a decade resistance box replaces the probes. The resistance box is set equal to the probe resistance (Fig. 4) at the minimum temperature to be measured, and the range potentiometer (LO) is adjusted for base output voltage (the lowest voltage in the desired output voltage span). It may be 0 volts for a 0 to 5 volt output (telemetering application) or −2.5 volts for a −2.5 to +2.5 volt output (oscillograph or other applications). The high end of the voltage output is reached by adjusting the sensitivity (HI) potentiometer with the resistance box set to equal probe resistance at the highest temperature to be measured on the channel. A complete system calibration is then made by selecting other resistance-temperature points and determining the output voltage.

A typical system voltage calibration is shown in Fig. 3. After all channels have been adjusted in this simple manner and the probes reconnected, the system is ready for use.

System limitations require a minimum temperature span of 250°F for 5-volt d-c output. No limitations exist for maximum temperature span. As subcarrier oscillators requiring only 0-1 volt d-c input may be secured, full-range frequency deviations may also be secured for temperature spans of 50°F. Commercial probes are available for temperatures between −100 and +1500°F with some limitations on linearity above 1350°F.

When commercial temperature probes are purchased, serialized calibration curves are normally furnished. However, where probe recalibration is required, or calibration of non-commercial probes is to be made, several precautions are necessary. The temperature calibration source must be capable of precise control and narrow bandwidth[6]. Stabilized probe temperature must be maintained for a period exceeding the time response of the probe, and for a long enough period to enable accurate resistance measurements to be made. Accurate means to measure the calibration temperature must be used, and temperature gradients must be minimized (see Fig. 1).

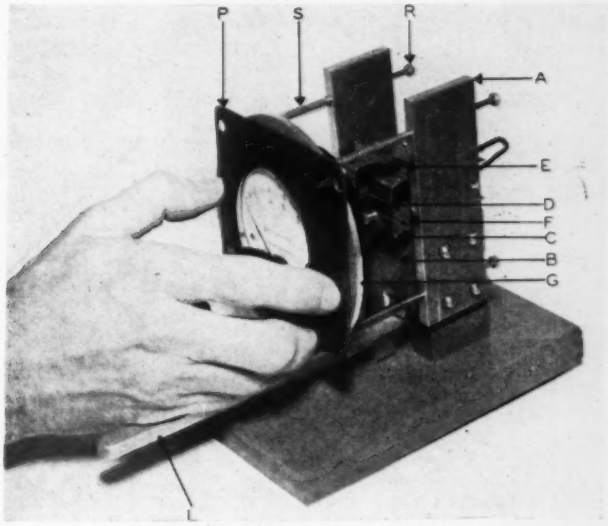
In measuring the resistance of the probes care must be used to limit the probe current to prevent I^2R heating with resultant inaccuracy in calibration. Generally a bridge excitation voltage producing a probe current under two milliamperes is satisfactory. A quick check as to the effect of probe I^2R heating may be made by determining the resistance value at the moment bridge excitation is applied, and again after several minutes. The dR change as referenced to the calibration curve indicates the resultant error in temperature measurement: proper system and probe calibration limits such error to a fraction of one percent of full range.

Fig. 6 shows a variation of the system, the Arnoux "Model CTI-10." For this application, indicator warning lamps are supplied to warn the pilot of an aircraft visually when excessive temperatures are reached. In this application, the bridge unbalance voltage is used not only to actuate a direct-reading panel meter, but also to trigger a magnetic amplifier which controls the warning lamps whenever the bridge voltage reaches a predetermined level.

References

1. B. Hamlin, *Flight Testing*, Macmillan 1946, pp 28-31.
2. J. Wynn & S. Ackerman, "Telemetry Subcarrier Separator," *Radio-Electronic Engineering*, Dec. 1953, pp 14, 15, 34.
3. P. Huss, "Important Factors in the Design of Bridge Networks Used in Instrumentation," ISA Paper 52-10-2.
4. *Handbook of Chemistry & Physics*, Chemical Rubber Publishing Company, 34th Edition, pp 2085-2091.
5. E. R. Letsch & W. J. King, "Methods of Measuring High Temperature in Gas Streams," ASME paper 51-A-143 (available by writing ASME, 29 W 39th Street, NY 18, NY)
6. Alvin B. Kaufman, "Electronic Temperature Controller," *Radio-Electronic Engineering*, March 1955, pp 10-11, 30-31.

Test stand for PANEL INDICATORS



FRED J. LINGEL and **V. T. BURKETT,** General Electric Company

PROPER MAINTENANCE of panel-mounted electrical indicating instruments requires consideration of the following factors:

1. Uniform readability should be provided by mounting the instrument to be tested at eye level in good light.
2. Instruments should be mounted rigidly in the position in which they will be used.
3. The proper panel should be applied. If a magnetic panel is used, the thickness and cutout should match that of the final equipment. Magnetic panel effects on some low-range microammeters with high-flux magnets can alter the readings by as much as 7%.
4. Magnetic components which may be near the instrument when in actual use should be placed near the test instrument, or allowance should be made for their effect. Transformers, relays, iron plates, and other instruments (especially sensitive d-c instruments with large magnets), can affect the calibration.
5. Connecting leads for high-current instruments should be brought directly back away from the studs as in the final installation. Unless this is done, a high-current lead running along the back of the instrument case may cause a change in reading of as much as 5% on some types of moving-iron a-c ammeters.
6. On high-sensitivity voltmeters, the electrostatic effect may cause a change in pointer indication should the leads overlap near the front of the instrument. At 1000 volts this error may amount to as much as 2%. *Lead location* is therefore also important on voltage checks.
7. The connecting leads should be *securely held* in position by strong spring clamps to prevent partial short circuits on ammeter checking. High-voltage connections should be well insulated. Variations in contact resistance should be eliminated by the use of high-pressure connections so that the control settings remain nearly constant for instruments of the same range. High-pressure contacts also reduce the possibility of overheating of the studs and resultant overheating of the instrument.

To meet these requirements, a mounting and connecting stand was developed as shown in the illustration. Features of this stand are (1) flexibility of mounting through interchangeable square panel plates behind the instrument, (2) firmly clamped, quickly made circuit-connectors; and (3) one-hand operation. The unit provides for holding almost all electrical instruments from 1"- to 4"-diameter types in all the popular models (Weston, G.E., Simpson, Triplett, etc.). The four coil springs (S) insure tension between the instrument and the panel at all times; this is important when checking calibration of low-range microammeters on steel panels.

Four ⅛"-diameter brass support rods (R) support the instrument from the 2 aluminum uprights (A). The two sets of 1/32"-thick by ¾"-wide phosphor-bronze connectors (C) open in both directions; the teeth on the clamps (D) have a slight twist to permit meshing into the threads on the connection studs. This holds the instrument firmly and provides a low-resistance connection.

The upper set of clamps is raised by a rod projecting up from the lever through the support block (B) to push against an insulating bar (E) shown across the top clamps. The lower set of clamps is depressed by a combination of the vertical rod and a short lever arm projecting toward the instrument and pressing down against the insulating bar (F).

In operation, the proper rectangular steel or aluminum panel of the required thickness and barrel cutout is placed on the instrument. The lever arm (L), on which the operator's hand is shown resting, is then depressed by the palm. This opens the spring connectors and permits placing the instrument with its test panel in the test fixture. The panel is then held securely in position against the instrument by the coil springs pressing against the aluminum ring (G). To release the instrument, the operator merely depresses the lever with his palm, thus releasing the instrument which springs away from the contacts into his hand. Where a large number of instruments of the same type is to be tested on one panel, the rectangular plate may be fastened directly to the aluminum ring with four screws instead of being held in position by the springs.

To permit testing instruments with special mounting-stud inserts it may be advisable to replace the cut-out aluminum ring (G) by a ⅛"-thick x 3⅜"-I.D. x 4⅜"-O.D. ring. The brass studs (R) are then threaded for ¾" and this threaded end is made to project through the ring.

A stand of this type, in use by the Instrumentation Sub-Section of the Material and Processes Laboratory at Electronics Park, has improved the speed and accuracy of routine indicator check and calibration.

Measurement of Temperature Coefficient of Resistance

In measuring the thermal coefficient of resistance, errors result from inaccuracies in measurement of resistance and temperature. Here is an analysis of the effect of these errors on the final result. Systematic errors in the measuring equipment have no effect provided that the same devices are used throughout the tests.

H. PHILIP HOVNANIAN

Scientific Specialties Corporation
Subsidiary of Norden-Ketay Corp.

VARIATION OF RESISTANCE with temperature has been observed as being of several types:

1. Most pure metals and some alloys having a conductivity nearly proportional to the absolute temperature in the room-temperature region[1].

2. Alloys such as manganin which are almost independent of temperature.

3. Alloys such as CuNi whose temperature rate-of-change of resistance from sample to sample varies from positive to negative, the frequency of distribution following a probability curve.

4. Semi-insulators like Cu_2O and Ag_2S for which the resistance increases with increase in temperature and which have a higher resistivity than pure metals.

5. Semiconductors like carbon, silicon, and germanium for which the resistance decreases with increase in temperature.

We have observed that the purer a sample such as Ni is, the higher is the rate-of-change of resistivity with respect to temperature.

Apparatus for Measurement

Fig. 1 shows a hot-oil and cold-oil bath, giving two reference temperatures. R_x are the resistances whose thermal coefficients are to be measured. The hot bath is a Cenco-DeKotisky constant-temperature bath (either Cenco Cat. #97200 or 97300). The latter will yield temperature control of about 0.005°C from 10 to 60°C. Room temperature is controlled to within ± 1°C.

R_s is the reference resistor for the bridge. It normally is a decade arm of the bridge. For certain applications, National Bureau of Standards' calibrated standards are used, immersed in the controlled bath.

The galvanometer G has a sensitivity of 0.0001 microampere/division deflection.

The Wheatstone bridge battery consists of 1.5- , 5- , 15- , and 50-v steps. These voltages correspond to resistance ratios of 1:10, 100, 1000, and 10,000, respectively. The temperature coefficients of bridge resistors are of the order of 15 ppm/°C.

For most high-precision work the Leeds & Northrup Anthony-Patterson Wheatstone bridge is adequate, as is the Trüb, Tauber Cat. #103905 bridge; the error limit in the ratio resistors of these bridges is ± 0.01%. However, for moderately precise work the L&N Cat. #4725 or T&T Cat. #103901 is adequate; these have a ratio-resistor error of about ± 0.02%. On the other hand, for extreme precision, special bridges such as the L&N Ratio Bridge (which is in use at the Western Electric Company, Haverhill, Mass.) should be used. The claimed accuracy of this bridge is of the order of ± 2 to 4 ppm.

Definition of Temperature Coefficient

The variation of ρ (resistivity) can be represented by the rapidly but not regularly converging series:

$$\rho_o = \rho_t/[1 + \sum_{i=1}^{i=\infty} \alpha_i (T_o - T_t)^i] \qquad (1)$$

where α_1, α_2, α_3, etc. (the coefficients at the lower temperature) decrease rapidly, and $T_o - T_t$ is the change in temperature. If α is used as the coefficient at the higher temperature, equation (1) is the same except that there is no division sign between the two terms on the right-hand side.

Over a range of about five to six hundred degrees absolute in the region of room temperature, α_2, α_3, etc. may be neglected so that α_1 may be written as:

$$\alpha_1 = \left(\frac{1}{\rho_t}\right)\left(\frac{\rho_o - \rho_t}{T_o - T_t}\right) ,$$

$$= \left(\frac{1}{\rho_t}\right)\left(\frac{\delta \rho_t}{\delta T}\right) , \qquad (2)$$

$$= \alpha_t .$$

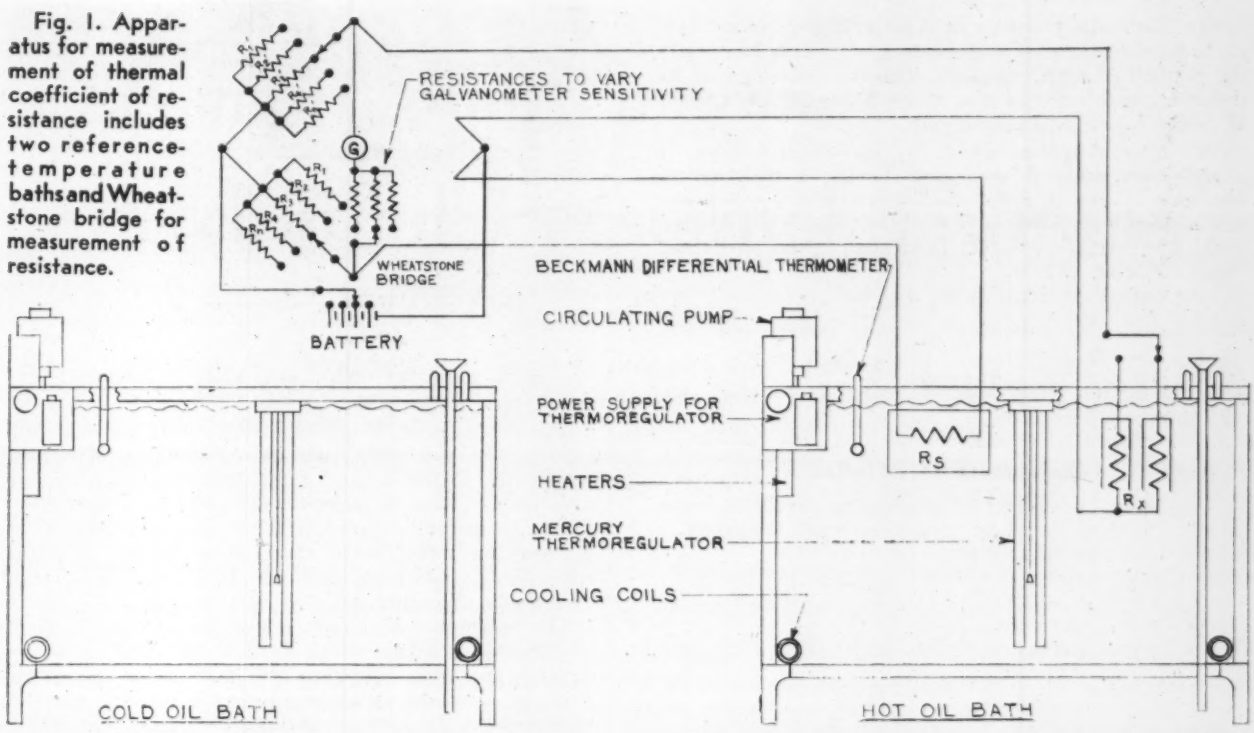


Fig. 1. Apparatus for measurement of thermal coefficient of resistance includes two reference-temperature baths and Wheatstone bridge for measurement of resistance.

This assumes a straight-line relationship between temperature and resistance. α_1 is then termed the *temperature coefficient of resistance*. This coefficient is nearly a constant for a given substance at a given reference temperature. Dimensionally, its value is T^{-1}. A suitable way of expressing the temperature coefficient is in parts per million per degree centigrade (ppm/°C). This conveniently does away with small fractional expressions of temperature coefficient. For example, the temperature coefficient of resistance of aluminum, which is 0.00423/°C, becomes 4230 ppm/°C:

Element	*Temp. Coeff. in ppm/°C*
Al	4230
C	—600 to —1200
Ni	5000 to 6000
Cu	4270
Nichrome Alloy	80
CuNi Alloy	20

Transformation of Temperature Reference

Assuming that a straight-line relationship exists between temperature and resistance, we can derive an expression for temperature-coefficient transformation from one reference temperature (T_t) to a neighboring temperature (T_o), i.e., from α_t to α_o:

From (1): $\rho_o = \rho_t/(1 + \alpha_t \Delta T)$.

From (2): $\alpha_o = (1/\rho_o)\ (\Delta\rho/\Delta T)$.

Substituting and solving for α_o:

$$\alpha_o = \alpha_t\ (1 - \alpha_t\Delta T)^{-1}. \qquad (3)$$

This is an exact expression for correcting the temperature coefficient from one temperature to another. For slide-rule work, the following approximation may be more useful. Neglecting all terms containing powers of α_t greater than one, equation (3) becomes:

$$\alpha_o = \alpha_t\ (1 + \alpha_t\Delta T). \qquad (4)$$

Note that in correcting α from a higher to a lower temperature, the coefficient is increased by approximately $\alpha_t^2\Delta T$.

Let us compare the correct formula (3) with the approximation (4) to show that the latter is satisfactory for many practical purposes. The *fractional error* in α is $\alpha_t^2\Delta T^2$, whereas the actual error is $\alpha_o\alpha_t^2\Delta T^2$. (The fractional error is $(\alpha_o - \alpha_o')/\alpha_o$, which is identical with the third term in the binomial expansion of equation 3).

As a specific example, let us consider Ni wire, whose temperature coefficient is 6000 ppm/°C at 35.00°C, and find the temperature coefficient at 30.00°C, using:

$$\alpha = 6000\ [1 + 6000(10^{-6})\ (30 - 35)],$$
$$= 5880 \text{ ppm/°C}.$$

The fractional error due to the approximation is

$$= (6000 \times 10^{-6})^2(35 - 30)^2 = 9 \times 10^{-4},$$
$$= 0.09\%.$$

Hence the coefficient, 5880 ppm/°C, is correct within 0.1%.

Effect of Resistances in Series

The change in resistance of a resistor (R) heated through a temperature change ΔT is:

$$\Delta R = R\alpha\Delta T.$$

For a number (n) of resistors in series, each with thermal coefficient α_i, the change in resistance is:

$$\Delta R = \sum_{i=1}^{i=n} R_i\alpha_i\Delta T = R\alpha\Delta T.$$

But: $R = \sum_{i=1}^{i=n} R_i$ for resistors in series.

Hence: $\alpha = \sum_{i=1}^{i=n} R_i\alpha_i / \sum_{i=1}^{i=n} R_i$.

Or: $\sum_{i=1}^{i=n} R_i\ (\alpha_i - \alpha) = 0.$ (5)

The significance of equation (5) is:

(a) For series resistors R_i ($i = 1, 2, 3 \cdots n$) with corresponding thermal coefficients α_i ($i = 1, 2, 3 \cdots n$), the product of each resistance with the difference of its thermal coefficient and the over-all thermal coefficient, all added together, is always zero.

(b) A usual application of (5) may be as follows: If a resistance value R is desired having a temperature coefficient α and no resistance material exists which has this α, then, say, two (or more) resistances are selected with one thermal coefficient more than α, the other less. Then, from eq. (5):

$$R_1 (\alpha_1 - \alpha) + R_2 (\alpha_2 - \alpha) = 0$$

But: $R_1 + R_2 = R$ (series resistors).

Thus: $R_1\alpha_1 + R_2\alpha_2 = (R_1 + R_2)\,\alpha = R\alpha$

(c) It is noted that without any approximations eq. (5) is independent of ΔT.

Resistances in Parallel

The thermal coefficient of resistors in parallel is more involved and, unlike the series-resistor case, is a function of ΔT. It can be shown that:

$$\sum_{i=1}^{i=n} R_i^{-1} \sum_{p=1}^{p=\infty} (-\Delta T)^{p-1} (\alpha^p - \alpha_i^p) = 0. \qquad (6)$$

For most practical purposes this simpler equation holds:

$$\sum_{i=1}^{i=n} R_i^{-1} [(\alpha_i - \alpha) - \Delta T(\alpha_i^2 - \alpha^2)] = 0. \qquad (7)$$

When $\Delta T\alpha^2$ and $\Delta T\alpha_1^2$ are less than α and α_1 respectively, then this approximation may be used:

$$\sum_{i=1}^{i=n} R_i^{-1} (\alpha_i - \alpha) = 0. \qquad (8)$$

The significance of this is that, as in the series case, various resistance materials can be selected to obtain a parallel combination with desired characteristics (resistance R and thermal coefficient α), or vice versa:

$$(1/R_1)(\alpha_1 - \alpha) + (1/R_2)(\alpha_2 - \alpha) + \ldots = 0$$
$$\alpha_1/R_1 + \alpha_2/R_2 + \ldots = \alpha(1/R_1 + 1/R_2 + \ldots) = \alpha/R$$

Error Magnitudes and Relationships

Errors in coefficient measurement may be cumulative. For example, as

$$\alpha = \frac{1}{\rho}\left(\frac{\Delta\rho}{\Delta T}\right).$$

$$\frac{d\alpha}{\alpha} = \frac{d(\Delta\rho)}{\rho} - \frac{d(\Delta T)}{\Delta T} - \frac{d\rho}{\rho}.$$

If we let $\Delta\rho = \rho_2 - \rho_1$; $\Delta T = T_2 - T_1$; $\rho = \rho_1$; this equation becomes:

$$\frac{d\alpha}{\alpha} = \frac{d\rho_2/\rho_2 - d\rho_1/\rho_1}{1 - \rho_1/\rho_2} - \frac{dT_2 - dT_1}{T_2 - T_1}. \qquad (9)$$

This equation states that the percentage error in thermal coefficient may be found from two terms. The numerator of the second term in this equation ($dT_2 - dT_1$) refers to the temperature error of measurement at T_2 and T_1. Assuming temperature T_2 is measured within 0.05°C.

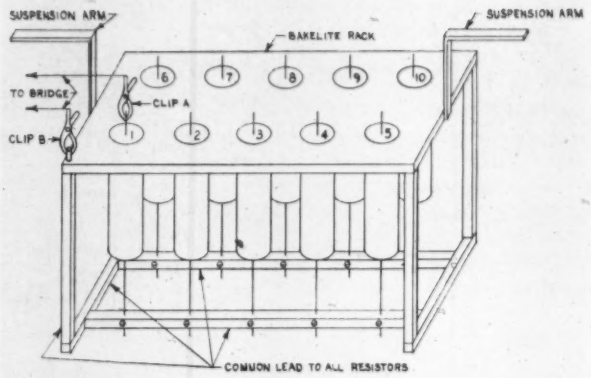


Fig. 2. Rack for resistances, which is immersed in oil bath.

and T_1 within 0.005°C, and that there is a 30-degree change in T, the second term becomes 0.055/30, or 0.183% error due to measurement error in temperature. (These temperature errors, 0.05°C in T_2 and 0.005°C in T_1, were the actual errors observed in the two oil baths respectively, indicating that one bath was better controlled than the other.)

The numerator of the other term in equation 9 refers to the bridge error, which is 2×10^{-6} for resistance changes less than 1%; 4×10^{-6} for greater resistance changes. The denominator of this term $(1 - \rho_1/\rho_2)$ equals $\Delta\rho/\rho$, or (from equation 2) $\alpha\Delta T$. This is the fractional change in the resistance due to heating through ΔT. Note that this is *not* the error in measurement of resistivity.

Typical errors in coefficient measurement are given in the table at the foot of this page, as calculated from the above considerations.

Note that as the temperature coefficient decreases, the error in measurement of the coefficient increases. This is because the fractional change in resistance becomes smaller, with attendant increase in the value of the first term on right-hand side of eq. (9). In samples like CuNi alloys, as α approaches zero the error computation tends to be infinite, and α indeterminate. This is independent of the method of measurement.

Aging

Aging, or power conditioning, appears to yield more stable and consistent temperature coefficients than does temperature cycling.

For example, two 37,000-ohm samples of NiCr wire showed a coefficient variation of about 5 ppm/°C in 24 hours (from 85 to 80); after aging at 118 v for 24 hours, the 24-hour variation was only about 1 ppm/°C (from 79 to 80).

References

1. Dauphinee, T. M., and Preston-Thomas, H., *Review of Scientific Instruments*, vol. 25, p. 884, 1954.
1a. Harnwell, G. P., *Principles of Electricity and Magnetism*, 2nd Edition McGraw-Hill Book Co., 1949, pp. 197-202.
2. Seitz, F., *The Modern Theory of Solids*, 1st Edition, McGraw-Hill Book Co., 1940.
3. Jackson, L. C., *Low Temperature Physics*, John Wiley & Sons, Inc., 3rd Ed., 1950.
4. Eisenstein, J., *Review of Modern Physics*, vol. 26, p. 277, 1954.
5. Seitz, F., *The Physics of Metals*, 1st Edition, McGraw-Hill Book Co., 1943, pp. 312-321.

Resistor	$\alpha\Delta T$	$d\alpha/\alpha$
Nickel	$5000 \times 10^{-6} \times 30 = 0.15$	$4 \times 10^{-6}/0.15 + 0.055/30 = 0.187\%$
Nichrome Alloy	$80 \times 10^{-6} \times 30 = 0.0024$	$2 \times 10^{-6}/0.0024 + 0.055/30 = 0.267\%$
Nickel + NiCr	$880 \times 10^{-6} \times 30 = 0.0264$	$4 \times 10^{-6}/0.0264 + 0.055/30 = 0.199\%$
Nickel + NiCr	$400 \times 10^{-6} \times 30 = 0.012$	$4 \times 10^{-6}/0.012 + 0.055/30 = 0.217\%$
CuNi Alloy	$20 \times 10^{-6} \times 30 = 0.0006$	$2 \times 10^{-6}/0.0006 + 0.055/30 = 0.417\%$

A Chemical Plant Program for

Instrument Personnel Training

An experienced nucleus of instrument personnel plus an extensive training program enabled this chemical company to meet an emergency program for plant reactivation. The training program included proper job introduction, training on fundamentals, field training, and training aids.

WILLIAM D. DeCOURCY

Koppers Company

IN AUGUST, 1950, the Instrument Department of Koppers' Kobuta Plant consisted of two supervisors, the Department Head and Assistant Department Head, and fourteen hourly employees. In order of increasing responsibility, the job classifications and grouping of these fourteen were: three Instrument Helpers, three Instrument Repairmen, six Area Instrumentmen and two Instrument Specialists. These men were responsible for the Instrumentation in our Styrene, Polystyrene, Phthalic Anhydride and Utility Areas. Fifteen separate plants comprise these areas, not including common facilities and the instrument shop.

In September, 1950, the Reconstruction Finance Corporation instructed Koppers to remove from standby, and place into operation, three of the four Government-owned Butadiene Units at our plantsite. These plants are a continuous process, completely controlled by instrumentation. The flow of some 110 individual process streams is recorded and controlled in each unit. Obviously, our Instrument Department was confronted with the necessity for an immediate increase in personnel. In this necessity we were not alone. Every department, operating as well as mechanical maintenance, required additional manpower.

Under our Union Agreement, the Instrument Department is a Departmental Group of the Maintenance Department. Maintenance personnel are given the first opportunity to bid on instrument-job postings. The job is awarded to the bidder with the highest seniority, and he is given a break-in period of thirty working days on the new job. Rarely do we find that a bidder from the Maintenance Department does not exhibit the potential necessary to fill the Instrument Helper job. On half the postings in 1950 we were unable to fill our job vacancies with personnel from the Maintenance Department. When this occurred, we posted the job plant-wide. Successful bidders on plant-wide postings had to be scrutinized more carefully as to potential instrument ability during their thirty-day-trial periods.

Experienced Nucleus

Of our original fourteen hourly employees, eight were top-flight instrument mechanics with six to twelve years experience in the instrument maintenance field. The other six were all capable of handling the next higher job. Without this nucleus of capable men around which to build, our task would have been next to impossible. Management's decision to maintain a more than adequate Instrument Department, prior to September, 1950, certainly was justified.

To meet the new demands of the Butadiene-Unit reactivation, our first move was to promote two of the most capable Area Instrumentmen to Instrument Foremen. We also hired a Stenographer-Clerk to take care of the records and paper-work. This firmed-up our supervisory staff at four, plus the clerk.

Of course, we were thoroughly familiar with the capabilities of our six Instrument Repairmen and Helpers. Within six months, they were all promoted to Area Instrumentmen. Within four months, our remaining twelve experienced instrumentmen had been augmented by seventeen new men. The profound interest in instrumentation was evidenced by the fact that all of our successful bidders had higher seniority than did the most senior man in the Service Department labor pool. *Five bid the Instrument Helper jobs in preference to other higher-paid job openings.* None of the new men had previous instrument experience. Nine came from maintenance, and eight from operations. One man was well versed in the repair of radio and electronic equipment. Our experiences closely paralleled those of many of you. Rarely are you able to hire an instrumentman; invariably you must train your own.

Introduction to Job

As our job vacancies are filled by seniority and not by individual selection, the first move is to find out all you can about the new man's education, background, experience and capabilities. Before the man arrives in the department, his Personal Record Folder has been forwarded from the department he is leaving. Therefore, we already know his Kobuta Plant experience. The new man reports to the Instrument Shop Foreman. This foreman introduces him to the other salary and hourly members of the department and then accompanies him to the instrument office. There, the Stenographer-Clerk completes his Personal Record Form for the department files and he is interviewed by the Department Head. From information obtained in this interview, the man is assigned to one of the three foremen. He is informed that he will be given

Presented at Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, March 25, 1954.

Fig. 1. W. D. DeCourcy, Department Head (right), and Instrument Specialists P. D. Lindell and W. E. Walker (left), lay out a shop pressure test-bench and graphic panel.

Fig. 2. M. N. Belich, Area Instrumentman (right), and A. G. Lewis, Instrument Repairman, discuss a maintenance problem at the shop demonstration panel.

instrument books and instruction pamphlets which he is expected to study on his own time. He is then given time to study the Instrument Helper's Job Description and to ask questions pertaining to it.

Although our three foremen are thoroughly familiar with the instrumentation in all of the areas on the plant-site, individually they are not responsible for all of them. Each has his own assigned areas. The assignment of the new man in a foreman's area is left to the discretion of the foreman.

First Week

After leaving the instrument office, the foreman conducts the new man to his assigned area. There, the foreman personally gives the man his first formal instruction. The Plant Safety Regulations are reviewed briefly and the safety rules applying to the specific area, and to instrument work in general, are covered extensively. The foreman then discusses some of the basic fundamentals of instrumentation and describes, in a general manner, the operation of the area and the function of the instruments in that operation. If nothing else, this briefing gives the new man an insight into the complexities of modern instrumentation. The faint-hearted have been known to bid a new job at this point.

The foreman then takes the man to the Area Instrumentman, under whose direction he will work, and there again the Job Description is reviewed. A seniority clause has its blessings too. It eliminates the old, erroneous feeling that if you show a man too much about your job, he may take it from you. Our instrumentmen have always outdone themselves to assist and instruct their new helpers.

Obviously, seventeen new men could not receive all their training from the three foremen. Usually the first fundamentals are learned from the Area Instrumentman. In less than one week, any helper worth keeping can relieve the instrumentman of many routine duties, such as calibrating pressure gages and thermometers, changing flowmeter range chambers, installing air tubing lines, etc. The responsibility for the job always lies with the Area Instrumentman. However, there is no limit to the variety of jobs that the helper can perform under the instrumentman's direction.

We feel that the early days are the most important period in our new helper's entire training program. Although he receives little or no formal training, it is then that he forms attitudes and work habits.

With the exception of home study and training, such as is offered by the Instrument Society of America, all formal training at Kobuta is given on company time. When we have a training session, we cannot remove all of our people from the areas. If the session is of general interest, we offer it twice; half the top men and their helpers attend each session.

Second Week

The second week after receiving new men, our supervision starts classes in fundamentals. Our first session is on use of tools. We distribute pamphlets that describe and illustrate the usage and application of the many tools necessary to perform instrument maintenance. All of our tools are purchased by the Company. We stress safety, the right tool for the job, and the correct use of the tool. The work habits of a former pipefitter must be adjusted from 36-inch pipe wrenches to 4-inch crescent wrenches. The foremen demonstrate the use of hand tools such as tubing benders, valve-seat-ring pullers, and the various special tool kits for individual makes or types of instruments. They also demonstrate the shop power tools such as the drillpress, the bench grinder, the engraving machine, etc. In all of our training sessions, wherever possible, we use the demonstration method of teaching.

We supply our new people two texts on instrumentation: *Fundamentals of Pressure and Temperature Instruments** and *Instruments and Process Control**. These are intended primarily for home study, but nearly every instrument work bench in the areas contains copies for reference.

Basic Physics

After the training session on tools, we devote the next several class periods to basic physics. Pressure, vacuum, and absolute pressure must be reviewed. Pamphlets are issued describing "U"-tube and well-type manometers and their usage. One of the hardest things to teach new men is the mathematics of the numerous pressure conversions. From inches of mercury to inches of water, or to pounds per square inch, is not too difficult a problem. A manometer manufacturer supplies us pocket cards that give all the conversion factors. A harder problem is the number of inches that should read on a manometer using 2.94-gravity red oil, when the product in the tank being measured has a gravity of 0.88.

With the exception of the Powerhouse, the centigrade

*Delmar Publishers, Inc., Albany, N. Y.

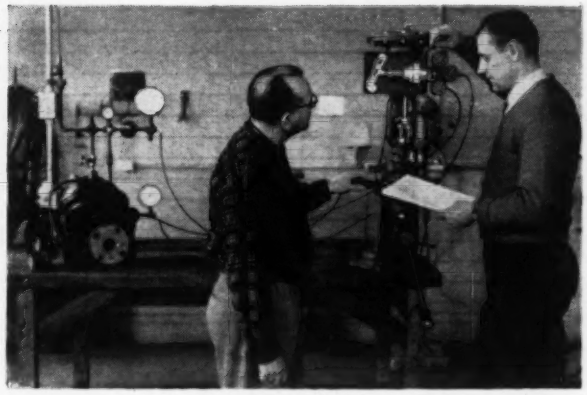


Fig. 3. A. J. Kayko, Foreman (right), and W. F. Strachan, Instrument Specialist, check the performance of a new control valve and positioner.

scale is used for all temperature readings in the Plant. Fahrenheit-to-centigrade conversion is taught, in one of our early classes, at the same time we demonstrate the calibration of pressure gages and indicating thermometers. Each man is given a pocket pamphlet listing the equivalent temperatures for either scale.

Fundamentals

More than half of the Kobuta instrument installations are for the purpose of measuring either flow or differential pressure. Most of these differential-pressure-type process meters have their measuring lead lines purged with high-pressure natural gas. We use the popular blow-back principle of purging, and fabricate our own restricting orifice nipples and valving manifolds. The first session on this broad subject is devoted to a brief discussion of the basic principles of flow measurement. Our intent is not to have a department of flow experts, but we do feel that every man should understand how flow can be interpreted as a function of differential pressure. Subsequent sessions are offered on the installation, maintenance and calibration of the measuring instrument, and on the installation and maintenance of the primary measuring device, the lead lines, and the manifold valving.

Following the sessions on differential-pressure instruments, we have classes on the calibration of thermal-system temperature and pressure instruments, and on the maintenance of diaphragm control valves.

Field Training

This completes our formal schooling in fundamentals and we now attempt to consolidate our gains. Under the supervision of the foremen, the new men are given work assignments employing the techniques learned from the instruction sessions. The new men's area assignments are rotated according to a prearranged schedule. Thus they are able to learn the process and the instrumentation in all the areas, and they can apply their classroom knowledge under the direction of different Foremen and Area Instrumentmen.

Due to the hazard of explosion, our multitude of automatic control instruments are practically all of the pneumatic type. The first basic fundamentals of pneumatic control, and of potentiometric temperature measurement, are not learned in the classroom. When we are ready for our instruction sessions on these subjects, each new man has already received field instruction in synchronizing a pneumatic controller, setting-up a valve positioner, calibrating a potentiometer, and maintaining a float-type level controller.

We have always found that the majority of our men are eager to help themselves. Many have joined the Instrument Society of America so as to avail themselves of the opportunity to attend the instrument maintenance clinics often held as part of the monthly Pittsburgh Section meetings. Quite a number have enrolled in an instrumentation course offered by the International Correspondence Schools. Several are studying radio and electronics at various night schools. Rarely have they needed encouragement to study the various bulletins and instruction pamphlets supplied by instrument manufacturers. This desire to learn the know-how of instrumentation is evidenced, in some form or other, by every one of our top men.

Keeping Abreast of Developments

Probably you are wondering how our supervision keeps abreast of modern instrumentation advances and new maintenance techniques. In the instrument office and in the foremen's office, we endeavor to maintain an up-to-date bookcase of instrument periodicals and reference books. We are all members of the Pittsburgh Section of the I.S.A. Every year, one or more of us attend the I.S.A. Convention and Exhibit. In 1952 all three foremen attended the I.S.A. Maintenance Clinic, held in conjunction with the Cleveland Convention. Frequently, a member of our supervision attends one of the repair training courses offered by various instrument companies at their factories. One of us is taking the International Correspondence School's instrumentation course along with the men. Another is studying electronics through a correspondence school. Still a third has completed the night-school instrumentation course at the University of Pittsburgh.

Training Aids

Recently, we installed a large demonstration panel in our shop. In this panel we have installed flow, temperature, and pressure instruments of the types most frequently encountered in the plant. When completed, these instruments will be coupled with orifice runs, and other variables, so as to actually measure and control in a manner simulating actual plant applications. This panel is a valuable training aid.

Four times we have shown our people the I.S.A. film, "Principles of Automatic Control".* We feel that this film is the most valuable training aid we have ever employed.

We have never been hesitant to seek assistance from the competent staffs of our many Pittsburgh instrument suppliers. Through the years, some of them have journeyed to Kobuta many times to demonstrate new instruments or to assist in our training by giving talks and demonstrations of the latest maintenance techniques. Much of our knowledge of pneumatic control and potentiometer maintenance has been acquired in this somewhat effortless manner. We cannot over-emphasize the valuable part that these men have played in our training efforts.

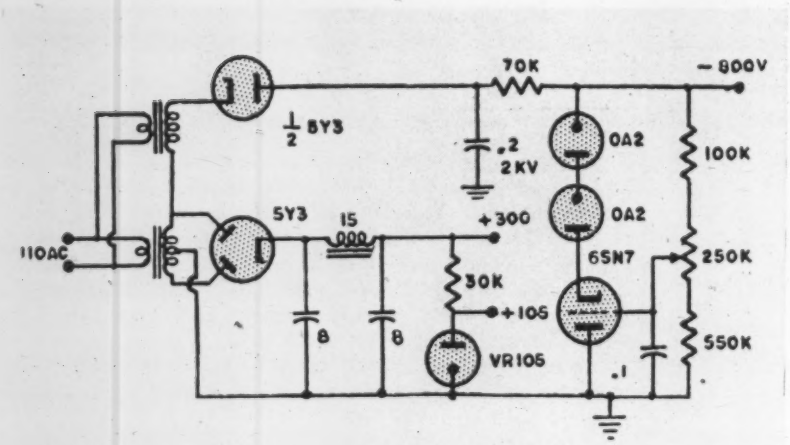
While the instrument training course as described here has its shortcomings, it is presented as an on-the-job training program which has proved sound and workable. It met our requirements; even though we more than doubled our personnel in less than six months, we still completed every job assignment before its deadline. We even were able to loan our two most experienced men to another company to assist in reactivating the instruments in two of their butadiene units. It is hoped that some of the training methods described may prove adaptable to your instrument personnel training programs.

*By G. F. Akins, Instrumentation Engineer, Eastman Kodak Co., Rochester, N. Y., and produced under the direction of R. Rimbach, Instruments Publishing Co., 845 Ridge Ave., Pittsburgh, Pa.

ELECTRONIC

—800-V SHUNT-REGULATED POWER SUPPLY

Regulation against changes in line voltage and load current is obtained with this circuit (developed for use with a photomultiplier tube). A regulated potential of —800 volts was required, with variable load current up to 2 ma. At normal line voltage, the d-c potential at the plate of the half-wave 5Y3 rectifier is about —1800 volts. When the potentiometer at the 6SN7 grids (the two halves



CHARLES F. KEZER
Potter Instrument Co.
and
MILTON H. ARONSON
Instruments Publishing Co.

are connected in parallel) is adjusted for an output voltage of –800, current through the 6SN7 and the OA2 regulator tubes is about 15 ma. As the voltage drop across each OA2 regulator tube is 105 volts, the potential at the 6SN7 cathodes is minus 590 volts (the grids will be a few volts more negative). If the line voltage increases, tending to make the output voltage more negative than –800, the potential of the 6SN7 grids becomes less negative with respect to the cathodes, and the tube draws more current. Resulting increased voltage drop across the 70,000-ohm series resistor compensates for the line-voltage change. Similar regulating action takes place when load current changes.

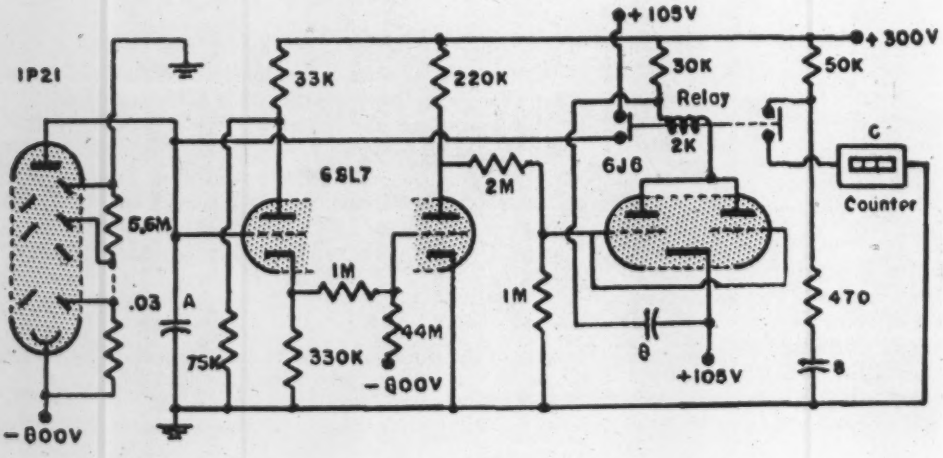
Regulation: Output voltage variation is about 2 volts (in 800) when line voltage is changed 20%.

Source: A. Vallance Jones and Herbert Gush, Physics Dept, University of Saskatchewan, Saskatoon, Saskatchewan, Canada; *Review of Scientific Instruments*, Sept., 1954.

LIGHT-INTENSITY INTEGRATOR

This exposure register integrates the intensity of light (auroral). Photomultipler current is integrated by capacitor A (0.03 uf) which is charged initially to 105 volts by the relay (whose contacts are normally open). When capacitor is charged, both halves of 6SL7 are conducting, parallel-connected 6J6 is cut off, and relay opens. When light falls on photomultiplier, photocurrent discharges A, causing rising signal at grid of 6J6, eventually causing 6J6 to conduct. This closes relay, trips counter, recharges capacitor A, and cycle repeats. Number of counts over a given period is thus the integrated intensity of radiation.

Accuracy of exposure measurement is affected by (1) phototube stability, (2) phototube dark current, (3) grid current of first stage of 6SL7, (4) leakage from capacitor A, and (5) variation of firing potential of entire circuit. Use of 1P21 rather than 931-A reduced the dark-counting rate to a negligible value. Stability of firing potential required regulated supplies (see previous circuit for power supplies).



Calibration was done with a blackbody source. Rate of 1 count/second (obtained from aurora of moderate brightness) corresponded to energy flux from calibrated source of 6×10^{10} quanta/sec/cm^2/steradian at wavelength of 5577 A.

Source: A Vallance Jones and Herbert Gush, Physics Dept., University of Saskatchewan, Saskatoon, Saskatchewan, Canada; *Review of Scientific Instruments*, Sept., 1954.

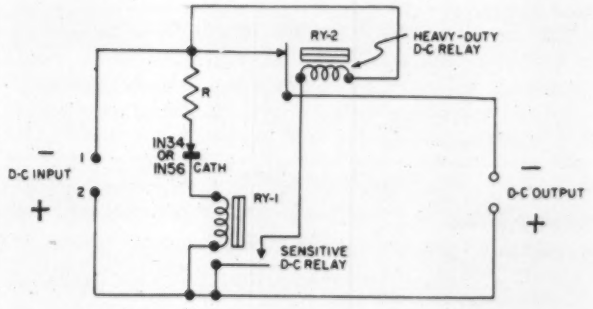
CIRCUITRY

The circuit is the heart of all electronics. Here are four more basic and interesting circuits. Unless marked, resistors are in ohms, capacitors in microfarads.

DC POLARITY SAFEGUARD

Some d-c operated devices (such as d-c motors, polarized relays, electron tubes, electroplaters and batteries on charge) must be protected against accidental reversal of the d-c polarity. This circuit uses two relays for this service.

Relay 1 (RY-1) is a relatively sensitive (up to 60 ma) d-c relay in series with a diode, which provides polarity sensing. It contacts are normally open and RY-1 is not energized when the polarity is proper, as shown. Under



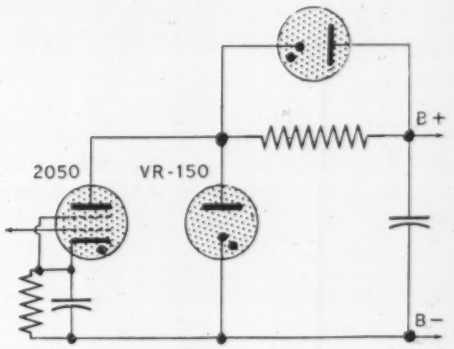
these conditions, heavy-duty relay RY-2 is also not energized; its contacts are normally closed, and the input is delivered to the output as if no relays were in the circuit. However, when the polarity is reversed, the diode conducts. RY-1 is operated, and energizes the solenoid of RY-2 (whose coil operates directly from the d-c supply voltage.) This opens the line and removes voltage from the output.

A 1N34 diode can be used for RY-1 if coil current is 50 ma or less; a 1N56 should be used if relay current is 60 ma. RY-2 can be any relay which can handle the d-c supply voltage, and whose coil current can be handled by the contacts of RY-1. Resistor R is used only if needed to limit the diode and relay RY-1 current to a safe value (depending on input voltage).

Source: Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.

CAPACITOR-CHARGING CIRCUIT

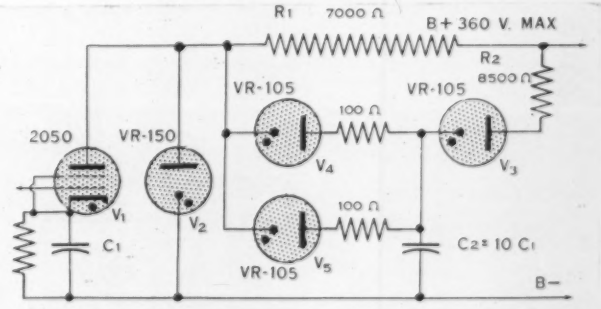
Many count-rate circuits and capacitor-discharge recorders require the charging of a capacitor in the cathode circuit of a thyratron. The charging of large capacitors can be troublesome; the sudden load can cause the thyratron to stop conducting before the capacitor is charged. This problem often is attacked by the techniques shown in circuit A, including (1) placing large capacitance



across the regulated supply, (2) placing VR tubes across the thyratron, (3) reducing the series dropping resistor, and (4) shunting this resistor with other VR tubes. These expedients have the disadvantage that the VR's across the 2050 draw current, and the others cause a heavy surge load to be imposed on the supply.

An improvement embodying the capacitor-reservoir idea is shown below. When power is turned on, V2 lights and stabilizes the 2050 plate at 150 volts. Tube V3 lights initially until C2 charges to about 255 volts, then goes out.

When capacitor C1 is to be charged, a trigger is applied to the thyratron grid, firing it. The plate voltage drops and V2 goes out. This fires V4-5, permitting the charge on large capacitor C2 to charge C1. As the po-



tential across C2 drops, V3 conducts to recharge it. As C1 charges, V2 comes on again, holding the plate at 150 v and limiting the voltage attained by C1. As C2 is much larger than C1, most of the C1 charge comes from the reservoir C2.

Advantages of circuit are reduced surge load on the power supply and better regulation of the capacitor charge.

Results: At count rate of 40 cpm (random cosmic-ray impulses), 11 month's of operation required 3 new 2050's and 4 VR-150's.

Source: Ronald L. Ives, Cornell Aeronautical Lab.; also *Instruments*, May, 1952.

Selection of
INSTRUMENT RECTIFIERS

The instrument rectifier converts the basic permanent-magnet moving-coil (D'Arsonval) indicator into an a-c voltmeter, milliammeter, or multimeter. This analysis discusses the effect of temperature and frequency on the indicator with a full-wave rectifier bridge in various services.

EDWARD L. PAGANO
Bradley Laboratories, Inc.

SELECTION of an instrument rectifier requires consideration of many factors, first of which is the specific application (voltmeter, milliammeter, or multimeter) for which it is intended, and the operating temperature, indicator parameters (resistance and voltage drop), and frequency.

Voltmeter Applications

To increase the range of a voltmeter, a multiplying resistance is inserted in series with the basic rectifier circuit, relating the voltage response of the indicator to the current response of the rectifier circuit and the total series resistance of the associated circuit. For this analysis, a copper-oxide full-wave bridge rectifier used in conjunction with a 0-1-ma 100-ohm d-c meter was selected (Fig. 1). Although the curves and specific values apply to this combination only, the basic concepts are the same for any combination.

Voltmeter Using Large Multiplier

Where a voltmeter incorporates a large multiplier, the multiplying resistance is much larger than the resistance of the rectifier.* Therefore, if this resistor is held constant as the temperature varies, any change of rectifier resistance will be so minute compared to the total resistance of the unit it can be ignored. For this type voltmeter it would be desirable to select a rectifier with minimum current variation with temperature.

From the equivalent circuit of Fig. 1c the following is derived:

$$I = FI_m \left(1 + \frac{R_m}{R_r} + \frac{R_f}{R_r} \right)$$

where F = form factor.

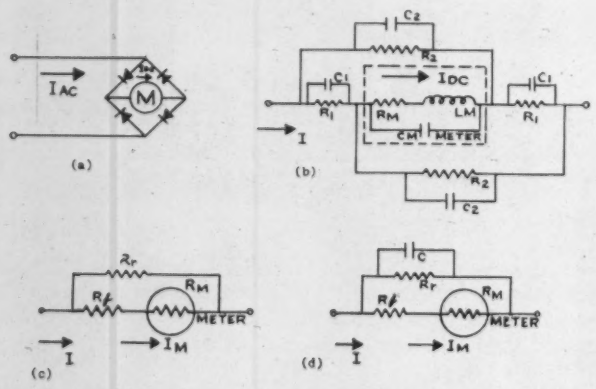
As the temperature increases, the resistance of the rectifier decreases; at high temperatures the reverse resistance can decrease to a point where it can greatly affect the amount of input current required to maintain a constant indicator deflection.

The current variation can be reduced by selecting (1) an indicator with a low internal resistance, (2) a small-diameter rectifier cell which has a high reverse-resistance, (3) a rectifier with a low ratio of R_f/R_r, or a combination of all three.

At low temperatures, the reverse resistance increases greatly; therefore, cell area has little effect on current response at low temperatures (Fig. 2).

Voltmeter Using Small Multiplier

If a small multiplier is incorporated in a voltmeter, the multiplying resistor may be comparable in value to the forward resistance of the rectifier. For this reason, both the current variation and forward resistance



R_1=rectifier forward resistance
R_2=rectifier reverse resistance
C_1=rectifier forward capacitance
C_2=rectifier reverse capacitance
R_m=indicator resistance
L_m=indicator inductance
C_m=indicator capacitance
R_1, R_2, C_1, C_2 are nonlinear and temperature sensitive compared to R_m, L_m, C_m.
$R_r = R_2/2$
$R_f = 2R_1$
$C = 2C_2$

Fig. 1. Basic full-wave-rectifier bridge circuit and equivalent circuits. Circuit (a) is bridge rectifier and indicator; (b) is complete equivalent circuit; (c) is simplified equivalent circuit for constant current and applied frequency; (d) assumes constant temperature and applied current.

*As a rectifier is a unilateral nonlinear device, the term "resistance" is meaningless unless accompanied by either a definite value of current or voltage. In this article, the term "forward resistance" is defined as the average resistance throughout the half cycle in which current flows internally within the rectifier from the negative electrode to the positive electrode at rated values of current. Similarly, reverse resistance is the average resistance throughout the remaining half cycle in which current flows internally within the rectifier from the anode to the cathode at rated values of voltage.

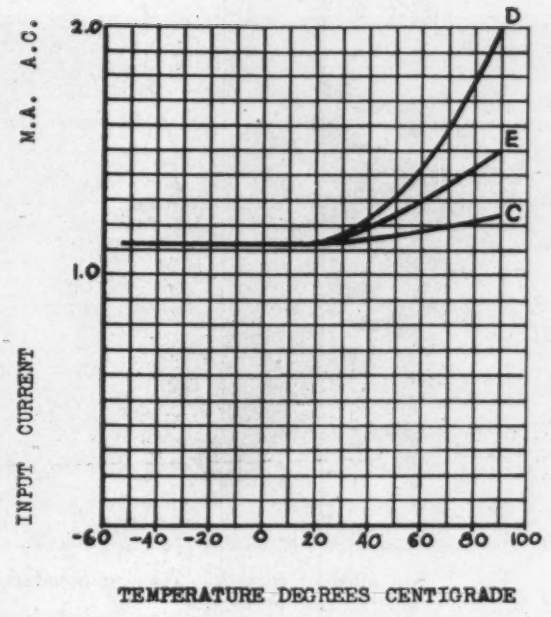


Fig. 2. Effect of temperature on current sensitivity (current required to produce full-scale indicator deflection) of full-wave bridge circuit with 0-1-ma, 100-ohm, d-c indicator. Cell C has 0.080" diameter; cell E has 0.187" diameter; cell D has 0.5" diameter.

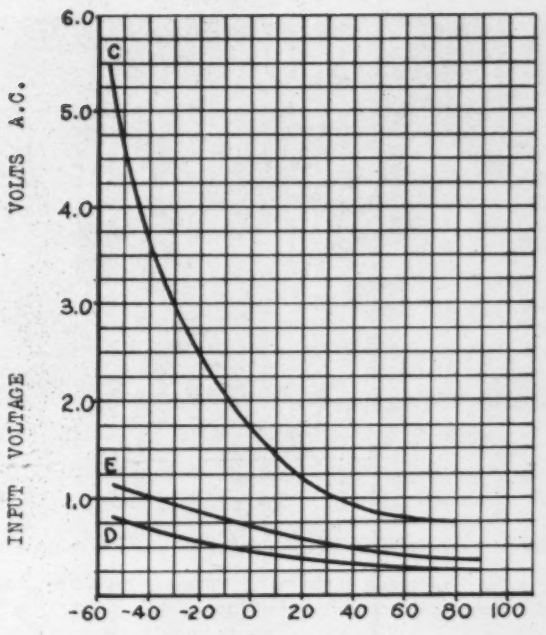


Fig. 3. Effect of temperature on voltage response (input voltage required to produce full-scale indicator deflection) of same full-wave bridge circuit with cells C, E, and D.

must be considered. At low temperatures it would be advantageous to select a rectifier cell with a relatively large area because of the low forward resistance. However, if the unit must function at high temperatures, the values of all circuit parameters should be checked with the rectifier manufacturer for the recommendation of a specific rectifier.

Current Applications

To extend the range of a milliammeter, a shunting resistor is placed in parallel with the basic rectifier circuit (Fig. 1c), causing the current response of the indicator to be directly related to the voltage response of the basic rectifier circuit. The voltage response of the rectifier can be analyzed from the equivalent circuit of Fig. 1c:

$$E_m = \left(\frac{E_1}{F}\right) \frac{1}{1 + \dfrac{R_f + \Delta R_f}{R_m}}$$

As the reverse resistance of the rectifier shunts the series combination of forward resistance and meter resistance, its effect upon voltage response will be negligible if it is much greater than the series combination.

Although the effect of the reverse resistance can be neglected, the change of forward resistance with temperature has a pronounced effect on voltage response. As the ambient temperature decreases, the forward resistance increases and necessitates an increase of input voltage to maintain constant meter deflection. This undersirable effect can be reduced by selecting (1) a meter with a large internal resistance, (2) a rectifier with a low forward resistance, or (3) a combination of both. Hence a rectifier with a relatively large cell area should be used because as cell area increases, the forward resistance decreases; since ΔR_f is directly related to the initial value of R_f, it too is decreased, reducing the temperature effect. Fig. 3 illustrates the effect of cell area on voltage response.

Multimeter Applications

As a multimeter must function as both a voltage and current device, the rectifier must exhibit good voltage and current response. Usually a temperature-compensating network is required. Fig. 4 shows a complete temperature-compensated rectifier network for multimeter applications.

Frequency Applications

When good frequency-response is required, both indicator resistance and cell size are important. Referring to the equivalent circuit of Fig. 1d, the frequency equation at the half-power point is:

$$f = \frac{1}{2\pi K_1 (K_2 + AR_m)}$$

As the frequency response can be improved with a decrease of indicator resistance, a small-diameter cell should be specified for this type of application.

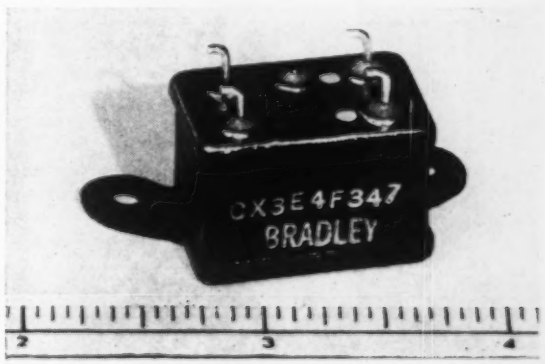


Fig. 4. Miniaturized temperature-compensated instrument rectifier for multimeter application.

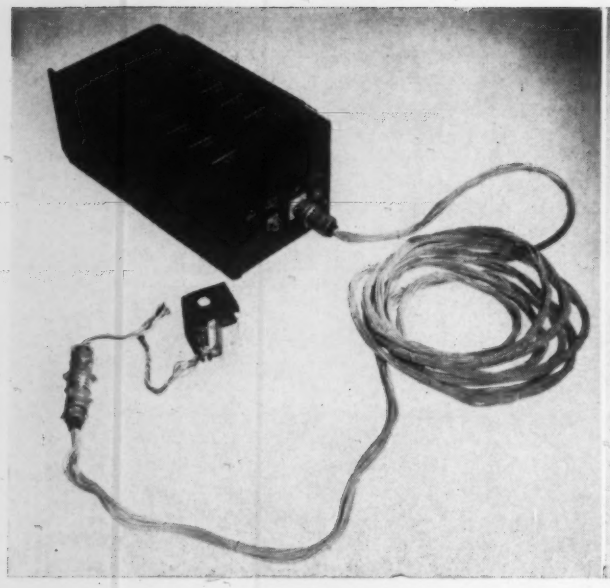


Fig. 1. Complete instrument showing recorder (top) and mechanical accelerometer (bottom).

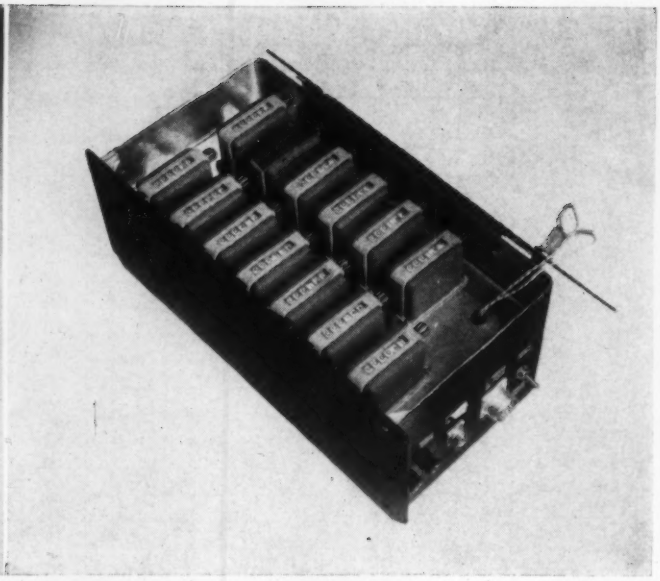


Fig. 2. Top view of recorder, showing counters.

Counters provide direct readout in this RECORDING

E. J. KIRCHMAN
Glen L. Martin Company

MARTIN ENGINEERS have developed a recording accelerometer (Fig. 1) for determining aircraft overhaul requirements, and for recording the gravity-induced shock and vibration forces acting on parts of an airframe. Acceleration data are read instantly from the window counters on the face of the instrument, and trace analysis is no longer necessary.

This recorder uses a standard mechanical accelerometer. However, the resistance card (Fig. 5) has been modified to give electrical pick-offs at each 0.66 g. Moreover, a slightly larger brush has been installed to carry the required currents. Stepping relays are used as indicating mechanisms.

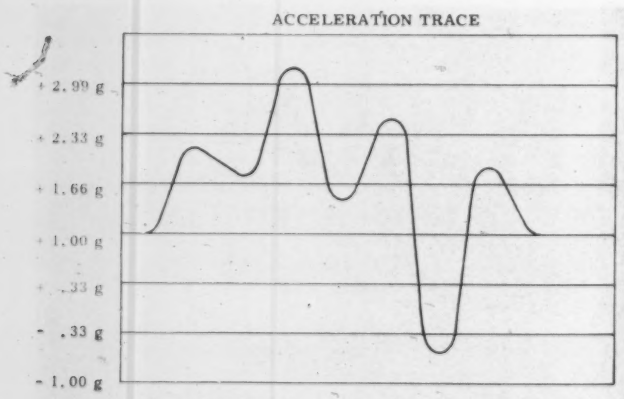


Fig. 3. Typical acceleration trace.

When airborne and set at zero, each counter registers the number of times the airplane is subjected to accelerations of a particular "g" level. The frequency response is good to 4 cycles per second—which is well below the first natural period of most aircraft components. This insures that only rigid body accelerations are measured.

When encountering an acceleration pattern such as in Fig. 3, the recording accelerometer would read as follows:

Instrument Readings

"g" level	*Counts*
+2.99 g	2
+2.33 g	4
+1.66 g	6
+1.00 g	4
+0.33 g	2
−0.33 g	2
−1.00 g	0

These readings, divided by 2, determine the actual number of times a particular "g" level has been exceeded. This fatigue information is used for gaging amounts of shock and vibration sustained in flight.

During development of the recording accelerometer, three types were considered. Construction factors eliminated the completely mechanical system; reliability factors offset the apparent advantages of a completely electronic one. It was decided to combine electrical and mechanical components. An electronic system shows promise at this time, however.

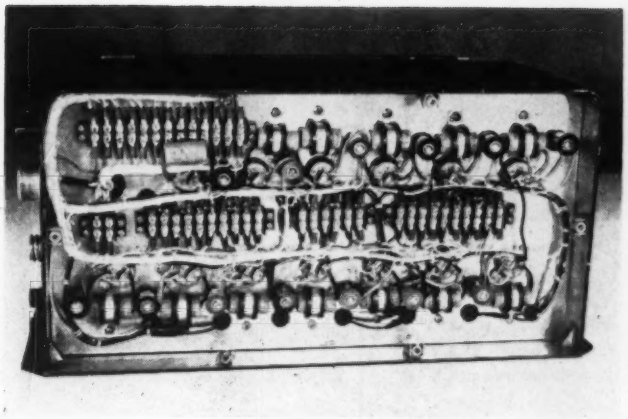


Fig. 4. Bottom View of Recorder.

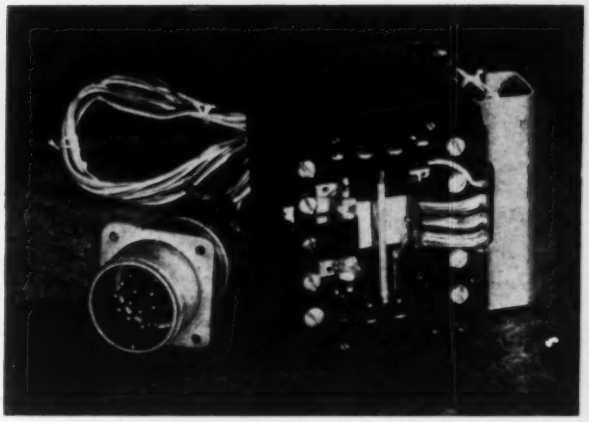


Fig. 5. Resistance card in accelerometer.

Measurement of metal fatigue in aircraft is one of the most serious problems of today. This accelerometer provides direct readout of the number of times any particular g level of a member is exceeded —and may become a standard aircraft operational instrument.

ACCELEROMETER

A Giannini Linear Accelerometer (type 24113) was adapted to measure the number of times different levels of acceleration are reached at the center of gravity of an airplane at a frequency in the order of 0 to 5 cps.

This standard accelerometer is magnetically damped to approximately 0.35 percent critical. The damped resonant frequency depends on the acceleration range for which the instrument is designed, and is approximately 16 cps for a range of ±7.5 g's.

In the Giannini accelerometer, the sensing element is a potentiometer whose wiper arm is attached to the movable mass of the instrument. Positive or negative accelerations force the wiper arm to move across the wire-wound potentiometer, causing proportionate changes of resistance to occur. The windings of the potentiometer are on a small cylindrical piece of insulating material called a "card."

This card and the wiper arm were removed from the modified accelerometer. A new resistance card was substituted, incorporating three windings of fine wire for each level of acceleration, or g, that is critical. Eight positive levels and four negatives ones, in increments of approximately 0.333 g's, are included.

These windings are 0.050 inch on center, 0.020 inch wide, and are separated by an insulating gap of 0.030 inch. They are set into the insulating material so that they present a smooth surface to the wiper arm. The geometry of the card, the difficulty in making each winding, and the dimensions of the original accelerometer determined the number of g levels and their increments.

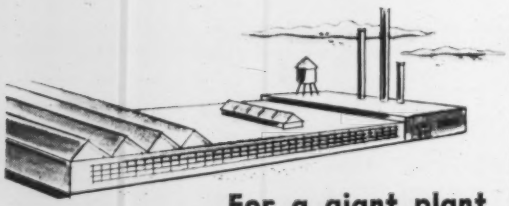
The modified wiper arm has two contacting surfaces to provide positive contact with the windings. From each winding on the card, and from the center contact point, fine wires extend outward through the instrument case to a terminal strip. Together, the windings and wiper arm act as switches for each acceleration level to which the instrument is subjected.

As switches, they cause ultra-sensitive Sigma Relays (Model 4 RJ-12000) to operate. There is a corresponding relay for each acceleration level. The relays incorporate single contacts, have a fast operating and release time, and draw a small amount of current (about 20 milliamperes).

These sensitive relays cause six-digit, reset-type Veeder Root counters to operate. The counters have relatively fast response, but with a slight modification, approach the desired frequency. Another modification damps the arc across the contact windings.

The relays and counters are packaged in a box 8 inches high, 10 inches wide, and 24 inches long. The faces of the counters protrude through the cover of the box. By lifting the cover, the counters can be reset.

Beyond the present lies the growing possibility that such an instrument may become a standard operational control, indicating overhaul periods based on fatigue cycles, rather than on fixed operating time—and accurately recording the fatigue history for each individual airplane.

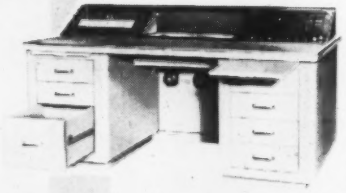


For a giant plant or a single laboratory loop

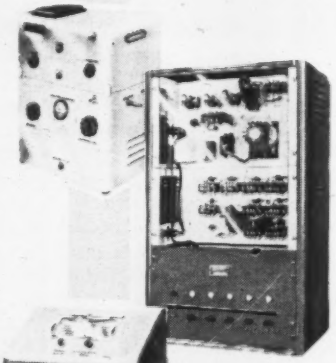
From *all-seeing* SARA that monitors entire plant operations to efficient units for detecting hazardous gases in laboratory or plants, Taller & Cooper control equipment is designed to meet industry's exacting needs specifically, economically, automatically. Here are four instruments that were developed by Taller & Cooper, which are easily incorporated in existing plants to perform various control and supervisory functions.

TALLER & COOPER MONITORING AND CONTROL EQUIPMENT

is engineered for automatic supervision

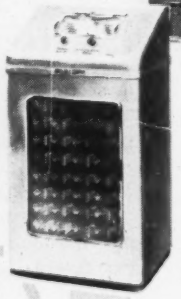


■ **SARA—Sequential Automatic Recorder and Annunciator** keeps an exact automatic log of as many as 500 separate plant operations continuously, automatically—and warns of any abnormal conditions.



■ **Supersensitive Analyzer for laboratory or control loop** detects hazardous gases as low as 5 parts per billion. In chemical control loop applications, it functions as analyzer, detector, monitor.

■ **Telemetering System for remote control of entire plant operation—** supervises multiple functions with only two wires. Affords complete plant control of 10, 16, 20, 32 or even 250 plant operations with the push of a button or switch.



■ **AUTOLOG automatically prints a permanent record of all plant operations.** Compact (48″x24″x15″) AUTOLOG automatically supervises up to 50 trouble points, records occurrence of trouble conditions, as well as return-to-normal.

Write today for Bulletins and Complete Details.

- CONTROL EQUIPMENT & SYSTEMS
- DIGITAL COMPUTERS
- TOLL COLLECTION SYSTEMS
- WIND TUNNEL INSTRUMENTATION
- SPECIAL PURPOSE PRINTERS AND INSTRUMENTATION
- CHEMICAL ANALYZERS & CONTROL EQUIPMENT

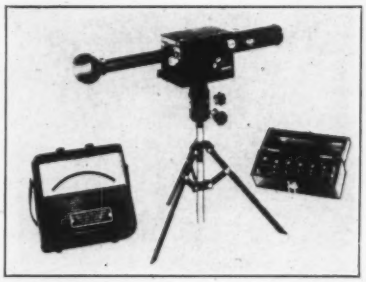
TALLER & COOPER, INC.

ENGINEERS • MANUFACTURERS

75 FRONT ST., BROOKLYN 1, N. Y.

For more information circle **224** on inquiry card.

NEW! PYRO Micro-Optical PYROMETER



Sufficiently portable to be used for general plant operations, the NEW PYRO Micro-Optical Pyrometer has been developed to meet the demand not only for higher degrees of accuracy, but also greater versatility in measurement of temperatures over 700° C. (1300°F).

It measures targets less than .001" in diameter, and by means of supplementary lenses, can be adjusted for focal distances from 5 inches to infinity. Mountings on table-top and floor-type tripods are available and vernier worm gears permit extremely fine vertical and horizontal adjustments of the telescope. Wide scale, direct reading meter makes for extremely accurate reproduction of temperatures. Ask for free catalog #95.

The Pyrometer Instrument Co.

Bergenfield 4, New Jersey
New Plant and Laboratory

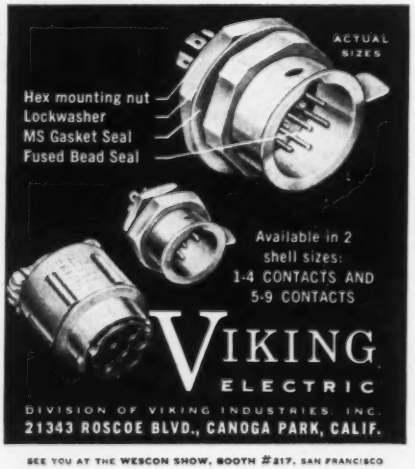
Manufacturers of Pyro Optical, Radiation Immersion and Surface Pyrometers for over 25 years

For more information circle **150** on inquiry card.

new VIKING *pressurized* MINIATURE CONNECTORS

Note these Viking features:

- **FUSED BEAD pressurizing for sealing around contacts**
- **MS GASKET for panel sealing**
- **POSITIVE POLARIZATION**
- **LOCKING DEVICE, simple and fool-proof**
- **PLATED SHELL...gold over silver**
- **AUTOMATIC ALIGNMENT**

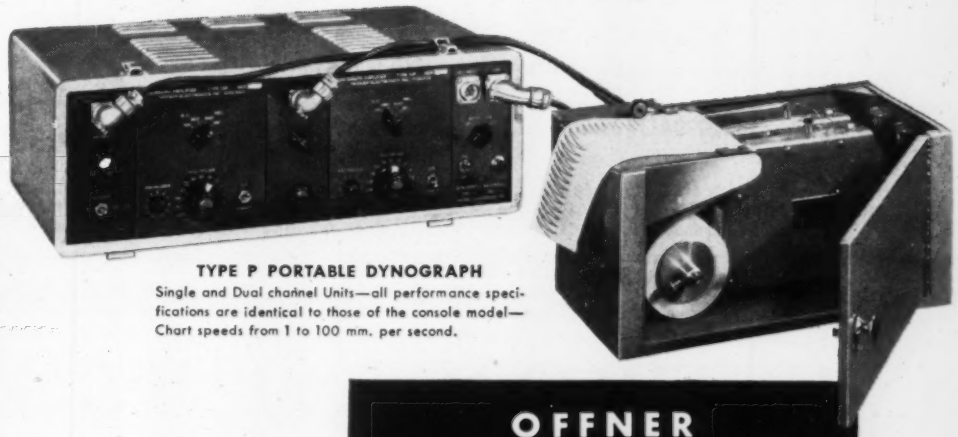


VIKING ELECTRIC

DIVISION OF VIKING INDUSTRIES, INC.
21343 ROSCOE BLVD., CANOGA PARK, CALIF.

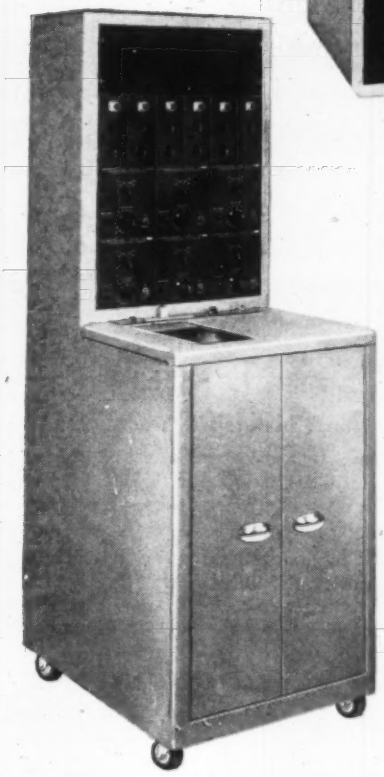
SEE YOU AT THE WESCON SHOW, BOOTH #217, SAN FRANCISCO

For more information circle **151** on inquiry card.



TYPE P PORTABLE DYNOGRAPH

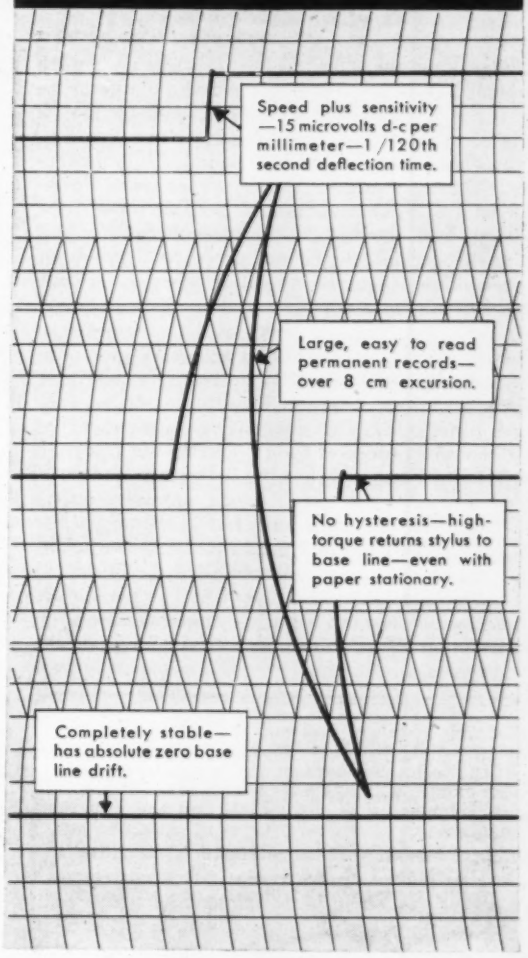
Single and Dual channel Units—all performance specifications are identical to those of the console model—Chart speeds from 1 to 100 mm. per second.



TYPE M CONSOLE

Six channels—accommodates up to six Type 146 amplifiers with input couplers, uses roll or folded charts—eight chart speeds, 1 to 250 mm. per second.

OFFNER DYNOGRAPH RECORDERS


Speed plus sensitivity —15 microvolts d-c per millimeter—1/120th second deflection time.
Large, easy to read permanent records—over 8 cm excursion.
No hysteresis—high-torque returns stylus to base line—even with paper stationary.
Completely stable—has absolute zero base line drift.

IF YOU COMPARE—YOU WILL SELECT THE OFFNER DYNOGRAPH!

Compare the direct writing oscillographs on the market today. If you do, you will select the Offner Dynograph because only the Offner Dynograph has these features:

15 microvolt per millimeter d-c sensitivity . . . Absolute *drift-free* stability . . . One amplifier for d-c amplification, resistance and reluctance gages . . . True differential input, isolated from ground . . . Rugged, low resistance movement.

No other direct writing oscillograph on the market has *any of these features!* The Offner Dynograph *has all these features and many more!*—because the Dynograph uses the exclusive patented Offner *chopper amplifier*. This amplifier must be distinguished from a chopper *stabilized* amplifier, which merely reduces, does not eliminate drift, and provides none of the other features of the Offner Dynograph.

If you want the widest versatility, highest accuracy, greatest reliability in direct writing high speed oscillographs—*compare them all!* You'll select the Offner Dynograph.

See all the latest models of Dynograph Recorders at the Instruments Society Show in Los Angeles, September 12-16. Booth A-289.

Write for your copy of Bulletin L-742.

OFFNER ELECTRONICS INC.

5326 N. Kedzie Avenue, Chicago 25, U. S. A.

For more information circle **106** on inquiry card.

Journal of the S C M A . . .

SOUTHERN CALIFORNIA METER ASSOCIATION

President: *Glen G. Gallagher*
Vice-President: *Philip Ver Planck, Jr.*
Auditor: *Earl W. Kramer*
Program Chairman: *Richard M. Voils, Jr.*
Secretary-Treasurer: *Geo. H. Forster, Jr.*, 640 Fillmore St., Fillmore, Calif.

ELECTRONIC CONTROLLERS

Two basic problems in the process control field are elimination of the effect of distance between process and instrument, and reorganization of the data-handling system. The "Microsen" system is offered as a solution. Transmitters, receivers, set stations, controllers, manual positioning stations, and electropneumatic valve positioners are described. Factors of interest to the plant instrument man include maintenance, installation, and power-failure safeguards.

JACK L. GATES

Manning, Maxwell & Moore, Inc.

WE have long since passed the day when we were content to read a pressure here and a temperature there; we now want to record and control a great variety of process variables. In fact, we are handling so many variables that we have overloaded the instrument room and the operators. A logical result was development of miniature instruments and graphic panels.

We have also been moving the instruments farther and farther from the process, while the processes have been getting faster. This requires a major change in our approach to instrumentation.

First, we must eliminate the effect of distance between process and instrument; we then can achieve closer control over faster processes. Next, we must organize our data-handling system to ease the operator's burden and, at the same time, assist the accounting department in using this data. (In processes today, and in the future, a few degrees temperature, or inches of water pressure, can make considerable difference in the annual report.)

There are cycles in the development of instruments. For awhile, the user may demand unavailable instruments; then the pendulum swings in the opposite direction. At the moment it seems that the instrument companies are ahead of the users. They are offering controllers, digital data handlers, and other equipment that will give the desired results outlined. In general, however, only those companies with instrument specialists are taking full advantage of these new devices. In order to meet competition, the others must follow.

The American Microsen Principle

Manning, Maxwell and Moore has come a long way toward solving these problems in the development of their "Microsen" process control system, a system that is compatible with most print-out, computing, and scanning systems. This new concept of automatic control should be discussed as a "system." We must consider the sensing elements, recorders, controllers, final control devices and other associated components as parts of the system.

The heart of the system is the "Microsen Balance." This (Fig. 1) is a small servomechanism operating on the principle of continuous torque balance, used to raise the power level of the input signal. It is a compact, rugged device with the sensitivity of a galvanometer. Fig. 1 shows a basic wiring diagram of a typical transmitter. In measuring mechanical motion (like that of a pressure or thermal element), force is applied through a combination of springs to one end of a balanced beam. In measuring an electrical input, the current is fed into a counter-wound coil in the field of a permanent magnet (which

In lieu of the regular meeting, the S.C.M.A. as a cooperating society with the I.S.A. will present three papers in the technical sessions at the I.S.A. Convention. These papers will be presented Monday, September 12th, commencing at 2:00 P.M. and the papers to be given are:

1. *Recent Progress in Orifice Meter Measurement*
   By: Richmond M. Voils, Jr.
   With General Petroleum at Santa Fe Springs
2. *Basic Elements for Pressure Control*
   By: A. M. Thackara
   With Mason-Neilan, Los Angeles
3. *Telemetering & Remote Control of a Natural Gas Pipeline*
   By: Walter E. Rufleth
   With Bristol Company, Waterbury, Conn.

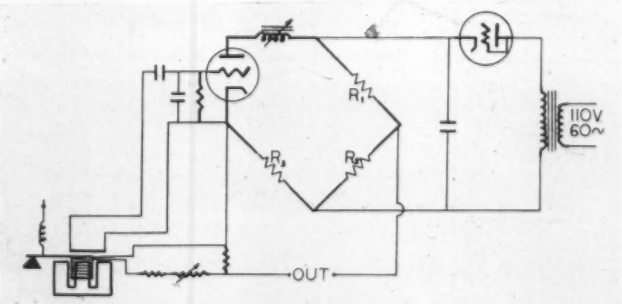


Fig. 1. The "Microsen" principle. Mechanical motion of coil in the permanent-magnet field detunes oscillator and changes bias of tube in bridge circuit. Change in plate resistance of tube causes output change of 0.5 to 5.0 ma, dc.

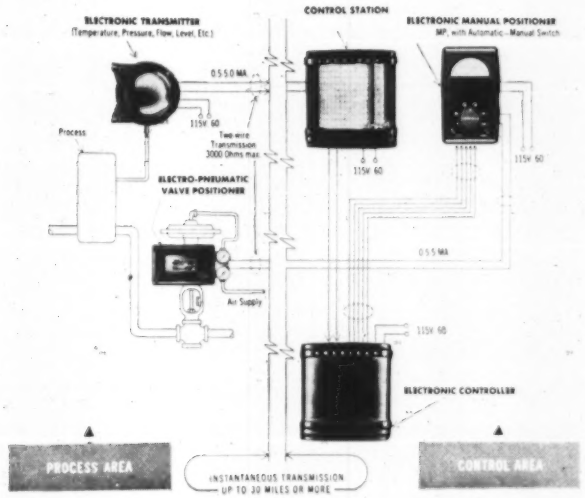


Fig. 2. Typical "Microsen" control system, showing transmitter, control station, manual positioner, controller, and electropneumatic valve positioner.

applies force to the beam). The free end of this beam can move in the field of a tuned oscillator coil, operating at 40 megacycles. The total movement is only a few thousandths of an inch for full control over the oscillator output. As the beam moves away from the coil, the oscillations increase in intensity. The direct-current impedance of the tube, (which is in effect one leg of a bridge circuit) varies with the intensity of oscillation because the grid leak on the tube supplies negative bias in proportion to the oscillator output. It changes from about 3000 to 20,000 ohms. This simply means we are changing the value of a resistor in one leg of a bridge circuit over the range of 3000 to 20,000 ohms. The unique feature here is that this is accomplished with no significant force being required.

The output of the "Microsen" is 0.5 to 5 milliamperes, direct current. This direct-current system is insensitive to capacitance changes in the external circuit, and to induced alternating currents. As a consequence, we can install the lines for power source, transmitted signal and controller output in one cable or conduit. We then have a stable system that can be used to operate many devices from the one output, with no loss of accuracy. The signal voltage will be a maximum of 15 volts with 3000 ohms resistance in the external circuit.

A unique refinement consists of a feedback circuit wherein a portion of the output current is fed back to a coil on the permanent magnet of the balance. This produces a null-balance position of the beam, and eliminates dependence on the stability of the electronic circuit.

We now have a basic element that is rugged, sensitive and self-balancing. It requires practically no force to operate, and gives instantaneous response over practically any distance. Around this device we have developed a complete system of electronic process-control devices, including transmitters (for all variables), indicators, recorders, automatic controllers, and electropneumatic valve positioners. Fig. 2 shows a typical control system.

Transmitters

We have two categories of transducers, or transmitters —mechanical input and electrical input. The *mechanical-input type* includes Bourdon-tube actuators used for pressure and some temperature measurements; for level measurement use is made of the rotational torque of a displacement-type level device or the differential-pressure

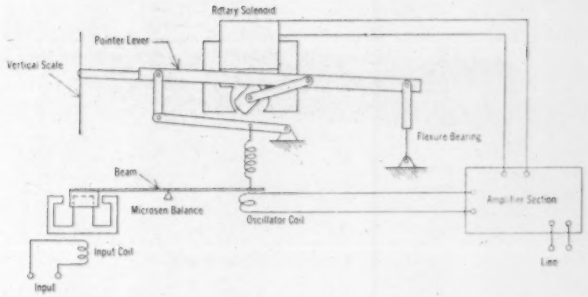


Fig. 3. Recorder or indicator section of the Set Station. Input from transmitter (left) is balanced against pointer position by "Microsen Balance."

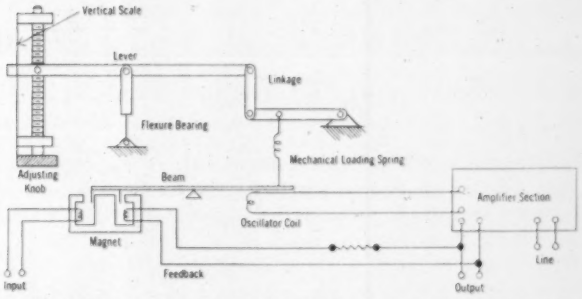


Fig. 4. Set-point section of Set Station selects the control point of the controller and also acts as preamplifier for signal. "Microsen Balance" detects any difference between selected set point and input from transmitter, and delivers amplified error signal to the controller.

devices of the bellows or ring-balance type; flow measurement is made by differential-pressure instruments. The *electrical-input transducer* is used for thermocouples or any electrical output from a pH amplifier, gas analyzer, or similar device. Any of these measurements are converted into our standard range of 0.5 to 5 milliamperes by the transmitter.

All transmitters are available in a choice of enclosure —general purpose, vapor-proof, and explosion-proof. All require an outside source of 115-volt, 50- or 60-cycle current. They are available also for 115-volt 25-cycle, or 120-volt direct-current operation.

Indicating and Recording Receivers

Indicating receivers take two forms—milliammeters and "Microsen." Milliammeter receivers are simply high-grade milliammeters calibrated for the variable being measured; they are available in various sizes and shapes.

The "Microsen" receiver indicators and recorders use the basic "Microsen Balance." The operation here is much the same as described for the transmitters except that the feedback is accomplished by the motion of the pen or pointer arm being turned on the shaft of the balance to give us the null-balance feature.

Set Stations

Set stations have two separate functions—recording (or indicating) and set point. The *recording section* (Fig. 3) consists of the rotary solenoid and a "Microsen Balance" which balances the pen (or pointer) position against the electrical input signal from the transmitter.

The *set point section* (Fig. 4) functions to select the value of the measured variable which is to be maintained by the controller. This section also acts as a preamplifier, the output of which is fed into the controller as an error signal. The "Microsen Balance" is also used in this section. It detects any difference between the input signal

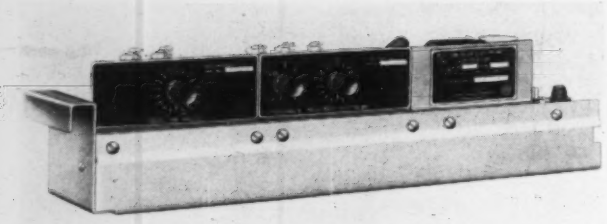


Fig. 5. Controller chassis.

and the control set point, and delivers a polarized output voltage, dependent on the direction and magnitude of the deviation signal. No voltage is produced when the process is exactly at set point.

The recorder is available with chart drums for IBM cards, or 30-day strip chart with internal chart storage.

The Controller

The controller (Fig. 5) is in a separate case, arranged for mounting on or behind the panel. It has two basic functions which are similar to those of a pneumatic controller—adjustable proportional band of 1 to 200%, and automatic reset with a choice of 10 to 0.1 or 100 to 1 repeats per minute. A third function, derivative (rate) action, is available for all controllers as a separate plug-in unit on the same chassis. Rate action is available in two ranges: 0.01 to 1 minute, and 1 to 10 minutes; it also is equipped with its own 200% fixed proportional band. Note on block diagram (Fig. 6) that rate is inserted ahead of proportional band, which assures immediate corrective action for any deviation signal. This arrangement, and the instantaneous transmission of signals of the "Microsen" system permits use of narrow proportional bands without sacrificing the protection of rate action. This combination of advantages results in control with minimum overshoot and cycling.

Rate action is obtained by delaying the degenerative-feedback voltage thru variable resistor S_1 and capacitor C_1.

Note in Fig. 6 that the output current flows through the valve positioner and the proportional-control resistor P_{22}. Consider resistor S_{21} as being removed from the circuit at this point. Consequently, an increase in input voltage means an increase in current thru resistor P_{22}, which in turn will increase the voltage fed back to the amplifier thru capacitor C_{21}. The amount of voltage fed back will be a function of the proportional-band setting.

Reset action is accomplished by the addition of resistor S_{21} in the circuit. As the capacitor discharges thru this resistor, the feedback voltage gradually decreases. However, if the feedback voltage departs from input voltage, the amplifier output will increase to counteract it, and the output current will gradually increase. Note that when input voltage is zero, the feedback voltage is zero; thus no current flows thru resistor S_{21} and the output current remains stationary.

Manual Positioning Station

The manual positioning station (Fig. 7) is available for use where manual positioning of a control valve is desired; it can be used with an indicator for conventional manual control. It provides a self-regulated source of direct current and a continuous indication of valve position. This device also incorporates an "Automatic-Manual" switch and a calibrated manual loading knob. This unit assures bumpless transfer from automatic to manual and return by merely flipping a switch. This is accomplished by a feedback arrangement that holds the controller output at the exact value of the manual positioner. Switching from automatic to manual is accomplished by matching the calibrated pointer knob to the valve position, as indicated on the milliammeter indicator, and flipping the switch. This device has many advantages on start-ups and lining out process upsets.

Electropneumatic Valve Positioner

The valve positioner (Fig. 8) receives a full-range signal of 0.5 to 5 milliamperes from either the controller or manual positioning station; it requires no other electrical power. It does, however, require a source of instrument air for the conventional diaphragm control valve. The operation is as follows: The "Microsen Balance" compares a force produced by the electrical input from the controller against a force produced by a calibrated spring which measures the valve stem position. If these forces are not in balance, the flapper on the "Microsen Balance" beam is repositioned. This changes the output of the air relay which moves the valve stem until a balance is reached. This device is a true valve positioner, not a mere transducer as normally used.

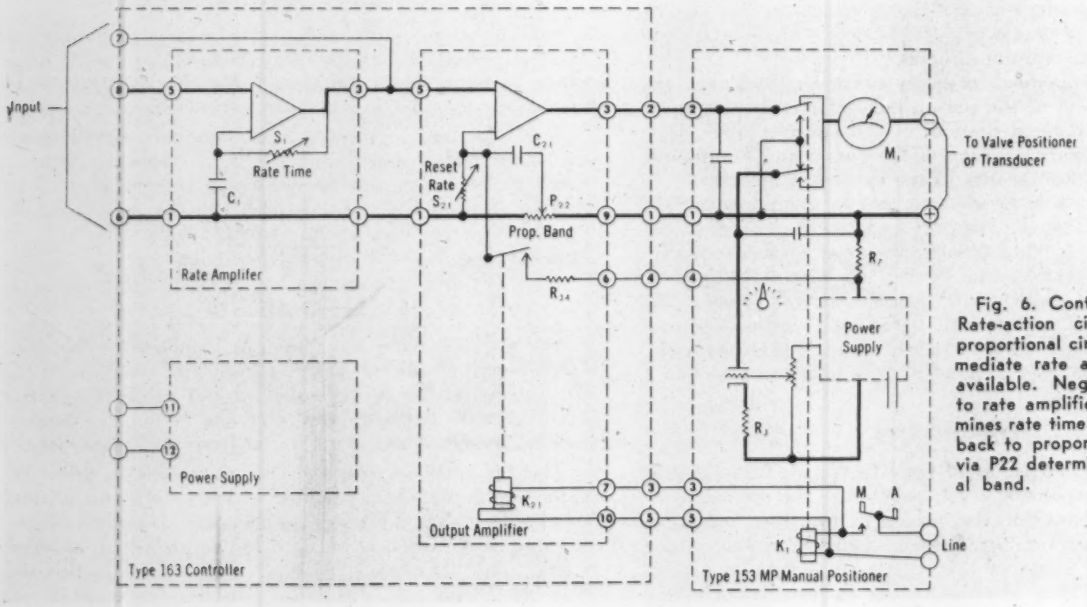


Fig. 6. Controller circuitry. Rate-action circuit precedes proportional circuit so that immediate rate action always is available. Negative feedback to rate amplifier via S1 determines rate time; negative feedback to proportional amplifier via P22 determines proportional band.

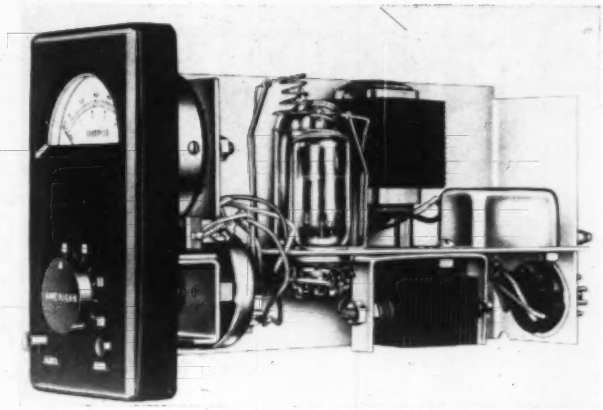


Fig. 7. Manual positioning station is used when manual control is desired, and assures bumpless transfer from manual to automatic control.

Another useful arrangement of this air-relay-"Microsen Balance" combination is the *electropneumatic transducer*. This is identical to the valve positioner *except* that the force balance is obtained by the addition of a bellows to the relay air output, which operates a linkage to the beam of the "Microsen Balance."

Maintenance

The entire assembly is composed of standard components that have been proved by years of application. Insofar as the operator is concerned, this equipment is identical in operation to the pneumatic equipment on which he "cut his teeth." There are, however, two major differences—the degree of accuracy is higher, and the speed of response is much higher.

All the instruments are of unitized construction and the components are interchangeable; with a small stock of spare plug-in units, it is simple to replace the offending unit and send it to the shop where maintenance facilities are available. Most instrument centers now have all the necessary, simple test equipment and many of the spare parts already on hand for the regular maintenance of potentiometers.

Some of you may wonder about the tubes used in these instruments. How often have you replaced the tubes in the family television or radio, or your automobile radio? Remember, your radio was built to meet the keenest competition. You can be sure every part in that set is loaded to capacity. In contrast, we are building a quality product, designed for long-maintenance-free life. We can afford to, and do, load the tubes to no more than half their normal rating. All other components are selected as conservatively as possible, and with all possible safety factors. We are using proved materials in a new application, and are not depending on new types of tubes or components. You will find a faulty electrical part less often than you do a plugged nozzle, wet air, leaky joint, or many other ailments common to pneumatic systems.

Cost figures have been published indicating that over a three-year operating period of one large electronic installation, costs for replacement parts averaged less than 0.05% per year of original-equipment cost.

Installation

Comparative costs between the way you did the job and what it would have cost for a different method are practically impossible to obtain. For example, I have never been able to establish the difference between the

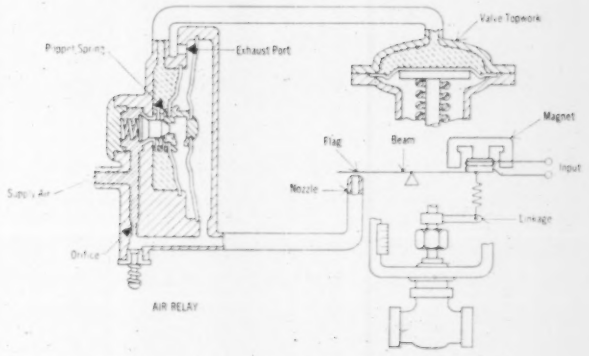


Fig. 8. Electropneumatic valve positioner requires only air supply and input signal from controller.

actual cost of a completely prefabricated control panel and one assembled in the field; I have always had to use factors such as appearance, savings in material, utilization of manpower, etc., to convince management that we should buy something that I knew was economic.

We have accumulated a mass of cost figures for specific cases but, with your permission, I would like to answer your unasked question with a few points about a hypothetical installation. Let's consider a 20-control-loop layout with an average distance of say 200 feet from the control panel to transmitter and control-element locations.

The electronic installation is a two-wire direct-current system; we can install our power wires in the same conduit with the ones handling transmitter and controller signals. For the first loop we need 2 wires for the power to the transmitter, 2 wires for the transmitted signal to the control system, and 2 wires for the controlled signal to the valve positioner—a total of six wires per control loop. But, once we have the basic requirements for power and a common or neutral, we need only two additional wires for each added loop, one for the transmitter signal and one for the controlled signal. We know #18 gauge wire is adequate for power and neutral for 20 control loops, and for the signals (which are a maximum of 12 watts). So we need 44 wires, or a 50-wire control cable which requires, at most, a 1¼" conduit.

Now, let's look at a comparable pneumatic installation. We need as many as 4 tubes per control loop. As there are no common or neutral tubes, we may need 80 tubes. As you know, tube racks for 8 or 80 tubes have to be quite elaborate. Compare this with the 1¼" conduit, and don't forget to consider labor and space requirements. Speaking of space, did you ever fight with the piping and structural engineering groups for the required space for an 80-tube rack?

Power Failure

Power failure is an item that must be considered. Plant management has long been aware of this problem; many plants have solved the problem in its entirety, while in others the hazard is recognized and process design is based on equipment "failing-safe." In the rare cases where an instantaneous auxiliary source of instrument power must be provided, the problem can be solved in several ways, depending on local conditions and on the individual assigned to the job. One solution is a small steam-driven generator, running idle, but connected to the instrument circuit via an instaneous automatic changeover switch in event of failure of regular power. Several systems of battery and charger arrangements also are available. This problem diminishes greatly in importance after it has been considered from all angles.

Test Your I. Q. (Instrument Quotient)

See Page 1358 for Answers

All Questions are based on editorial matter in this issue.

Question 1

In operating computer facilities (such as ARL-WADC, Cyclone-Reeves, DSCL-Goodyear, or PCC-Electronic Associates) it has been found that an average problem requires a number of operational amplifiers in the order of

(a) 5- 10
(b) 15- 25
(c) 50-100
(d) 150-200

Question 2

Checking procedures used to check analog-computer solutions of problems include

(a) checking of machine and minor loops
(b) solution by analytic means
(c) solution by digital computer
(d) all the above

Question 3

The operational amplifier in an analog computer is used as

(a) an inverter, or sign changer
(b) a summing amplifier
(c) an integrator
(d) all the above

Question 4

Advantage of using an analog computer for analysis of process control problems is that

(a) numerical answers are given by the computer
(b) process constants need not be known
(c) controller constants need not be known
(d) effect of each constant can be evaluated

Question 5

The average city gate station in a natural-gas pipeline system has

(a) one run
(b) two or three runs
(c) five or six runs
(d) ten or twelve runs

Question 6

In natural-gas transmission pipelines the city gate stations are stations where

(a) local utilities receive their gas
(b) metering is done
(c) pressure is regulated
(d) all the above is performed

Question 7

Newest features of the modern Algonquin Transmission Co. pipeline are

(a) selective calling and multiplexing
(b) telemetering of all variables
(c) continuous recording of all variables
(d) all the above

Question 8

Basic reason for multiplexing in a natural-gas pipeline telemetering system is that

(a) transmission-line costs are reduced
(b) simpler equipment is required
(c) gas can be used out of line storage
(d) remote control is made possible

Question 9

Basic effect of adding rate control to a proportional controller is

(a) elimination of offset
(b) reduction of overshoot
(c) increase of proportional band
(d) all the above

Question 10

Advantage of a half-bridge modified Wheatstone circuit over a conventional Wheatstone bridge is

(a) faster response
(b) only one active leg
(c) output is at ground reference
(d) all the above

WILDER PROJECTOR

The MICRO-PROJECTOR with the VERTICAL DESIGN

• New Gage Company Precision Plastic Comparator Charts made on non-changing, unbreakable material; available for 360° angular checking, radii, threads and special charts to your specifications. • The Wilder so equipped will inspect faster, more accurately, without the need of to-scale manually built drawings.

Economy • Accuracy • Moderate Price

Geo. SCHERR OPTICAL TOOLS, Inc.

200-MG LAFAYETTE ST. • NEW YORK 12, N. Y.

For more information circle **155** on inquiry card.

ENGINEERS

Creative Opportunities with Republic Aviation

Research

Vibration Engineer

Two to five years aircraft vibration experience required. Shock and vibration theory and a practical knowledge of electro-mechanical shaker application as used in experimental research testing of complete airframes for flutter analyses and component investigation essential. Familiarity with usage of accessory electronic instrumentation equipment desired. Graduate with M.E. or A.E. degree preferred.

Please address complete resume, outlining details of your technical background, to:
Assistant Chief Engineer
Administration
Mr. R. L. Bortner

REPUBLIC AVIATION

FARMINGDALE, LONG ISLAND, NEW YORK

For
PILOT LIGHTS
CONSULT

DIALCO

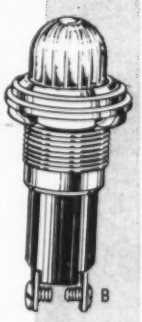
A

Your product benefits 3 ways from the use of a DIALCO Pilot Light:

Enhanced appearance: The glow of light and sparkle of a lens add colorful visual attraction.

Greater safety: A timely warning flashed by a pilot light can prevent damage to equipment.

Added service: Discs inserted behind lenses can be used to deliver specific messages, such as "FUEL LOW", "ON", "OFF", etc.

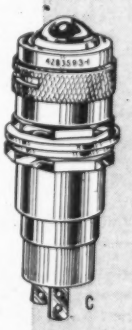

B

Let the Dialco engineering department assist you in selecting the *right* lamp and the *most suitable* pilot light for your needs.

Dialco offers the *complete* line of pilot lights, from sub-miniature types to giant units with 1½" lenses.

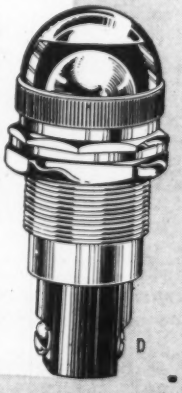
Every assembly is available complete with lamp.

SAMPLES ON REQUEST AT ONCE — NO CHARGE


C

Illustrations are approx. 70% actual size . . . *(A)* No. 8-1930-111 sub-miniature pilot light . . . *(B)* No. 521308-991, with multivue cap . . . *(C)* No. 922210-111, dimmer type . . . *(D)* No. 47901 with light shield cap.

Write for Catalogues L-151, L-153, and L-154

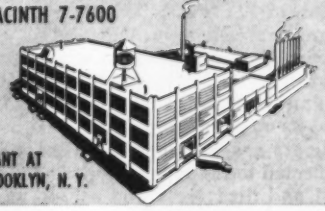

D

Foremost Manufacturer of Pilot Lights

DIALIGHT
CORPORATION

60 STEWART AVE. • BROOKLYN 37, N. Y.

HYACINTH 7-7600

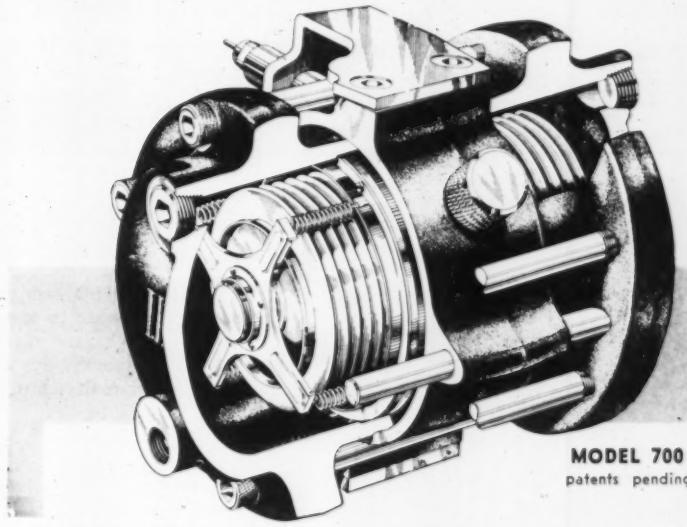


PLANT AT BROOKLYN, N. Y.

For more information circle **156** on inquiry card.

PROVED SUPERIOR

by major companies enthusiastically placing repeat orders



MODEL 700
patents pending

Major companies throughout the world have tried the I. I. C. bellows-type flow meter. In their own exhaustive tests they have found it far superior in performance and construction.

The I. I. C. flow meter is a combination of the most modern engineering features:

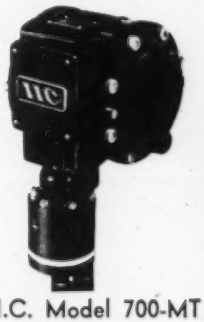
Seamless bellows—choice of either type 316 stainless steel or Monel.
Exclusive free-floating, non-freezing bearing designed and engineered by I. I. C.

Forged housings—either alloy steel or 316 stainless.

More powerful, this meter gives quicker response and more accurate recording. Pulsation dampener is externally adjustable under pressure. Compensation is provided for ambient temperatures. Affords over-range protection up to housing rating. Working pressures 1,000, 2,500, 5,000 p.s.i., furnished in all standard ranges up to 500 inches of water.

Make your own comparison tests. YOU be the judge.

For full information—including the name of your nearest representative, write for Bulletin 56-B-2—today!



I.I.C. Model 700-MT Transmitter
(Patents Pending)

Model 800-6 Indicator
(Patents Pending)

Model 802 Recorder
(Patents Pending)

IIC® INDUSTRIAL INSTRUMENT CORP.

DRAWER 152 ODESSA, TEXAS

For more information circle **157** on inquiry card.

Briefs . . .

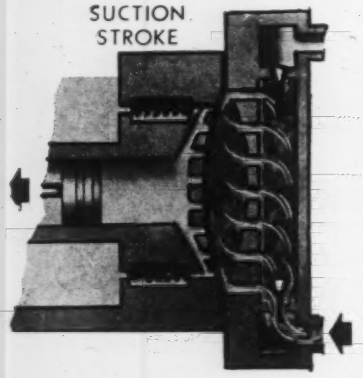
INSTRUMENTS and AUTOMATION

For this literature use postage-free order card on page 1373

Micro Pulsafeeder

The Micro Pulsafeeder is a positive displacement diaphragm pump. It has no stuffing box, packing or running seal in contact with the product pumped.

Conventional diaphragm pumps have a mechanically operated diaphragm suitable for only relatively low pressure operation and subject to varying displacement as discharge pressures vary. This is caused by the elasticity of the diaphragm.



Conventional plunger or piston pumps employ a stuffing box to seal product pumped from leakage; however, as discharge pressure varies, output is almost constant.

The Lapp "Microflo Pulsafeeder" combines the best features of both piston and diaphragm pumps by using a piston for constant volume measuring purposes and a diaphragm to positively seal the product pumped from leakage or contamination.

As the piston advances within a cylinder, it causes oil to exert a balanced hydraulic pressure against a diaphragm and move the diaphragm forward which in turn forces product pumped through the outlet check valve. Conversely, as the piston returns on suction stroke, it withdraws hydraulic liquid and returns the diaphragm to its original position. Continued movement of the diaphragm alternately forward and backward, the amplitude dictated by piston displacement, causes product handled to be pumped.

The piston does all the work of measuring liquid pumped and building up the pressure to the required discharge pressure rating. No strain is imposed on the diaphragm, the diaphragm acting only as a separating membrane between hydraulic oil and product pumped. (*From new* 4-*page Bulletin* 500, *Lapp Insulator Co., Inc., Leroy, N. Y.*)

For this literature circle **501** on inquiry card.

Spray-clean Technique

The Cobehn High-Velocity Spray-Clean Technique is extensively used in the aircraft and electro-mechanical instrument fields for the critical cleaning of precision ball bearings, etc. Such bearings, with their close axial and radial tolerances, are difficult to clean by degreasing, brushing, or low pressure spraying with conventional solvents or detergents.

The finely atomized particles of Cobehn Solvent are driven into the bearing by warm air under high pressure and completely dissolve the binder of oil and grease. The nonsolubles, such as dirt, lint, and metal chips, are then blasted away by the high-velocity warm air stream. Even fingerprints, which are the cause of later corrosion, are removed and the bearing is made chemically clean and dry for assembly into the instrument. (*From new* 8-*page brochure, Cobehn, Inc., Caldwell, N. J.*)

For this literature circle **502** on inquiry card.

Program Control

Program control is the use of automatic control instruments to carry out a predetermined processing or testing schedule on a time and conditions basis. The conditions can involve such variables as temperature, pressure, flow, density, humidity, conductivity and any other measurable

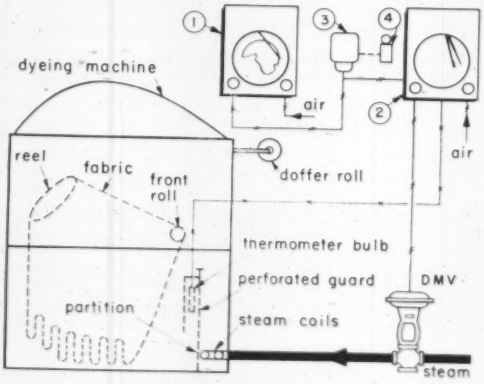


Fig. 22-1—Piece dyeing control system: 1—*Time-Pattern Transmitter*, 2—Recording Thermometer *Throttlor* Controller, 3—*Pressuretrol*, 4—Alarm Bell.

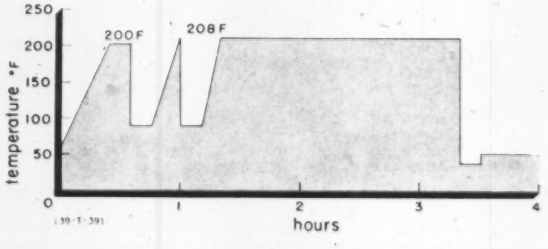


Fig. 22-2—Piece goods dyeing program.

condition. The instruments will control both the magnitude of the variables and the rates and times at which they change.

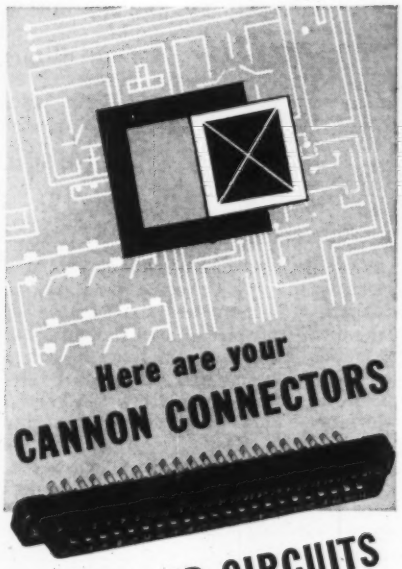
Automatic control of programs contributes to processing efficiency in several ways. It secures exact compliance with processing procedures . . . maintains consistent quality . . . reduces need for operator attention . . . increases productivity.

Proportional control with automatic reset is generally the best suited control method. This is because reset tends to eliminate offset caused by the changing positions of the set point index which, in effect, constitute a load change on the process.

Types of program controllers include:

1. *Electronik Strip-Chart* instruments with electric motors to drive the set-point index, plus limit switches. Advantages are that limit switches, times, and conditions are adjustable.

2. *Cam programmers* are circular-chart controllers with a cam follower connected to the index pointer, Advantages: cams easily labeled and filed; program set up as soon as



for PRINTED CIRCUITS

Available in 5 Sizes

1. **DX-1052.** Length 2-13/32". 10 contacts, spaced 5/32". For cards 0.057" to 0.067" thick.
2. **DX-1852.** Length 3-21/32". 18 contacts, spaced 5/32". For boards 0.060" to 0.071" thick.
3. **DX-2252.** Length 4-9/32". 22 contacts, spaced 5/32". For boards 0.060" to 0.071" thick.
4. **DX-2842.** Length 4-9/32". 28 contacts, spaced ⅛". For boards 0.060" to 0.071" thick.
5. **DY-4453.** Length 4-9/32". Double row, total of 44 contacts, spaced 5/32". For printed circuit boards 0.062" to 0.100" thick.

Nylon plastic shells . . . gold plated contacts

DX contacts of phosphor bronze; DY of beryllium copper. All contacts "grip" the board, which enters to a depth of approximately 11/32". Each rated at 5-amp. Polarization studs provided. Flashovers 2000 and 2500 v. 60 cps ac rms.

Single-row types for boards printed on one side only, or both sides common. Double-row type for boards printed both sides having different circuits, not common.

Please refer to Dept. 180

CANNON PLUGS

40th YEAR

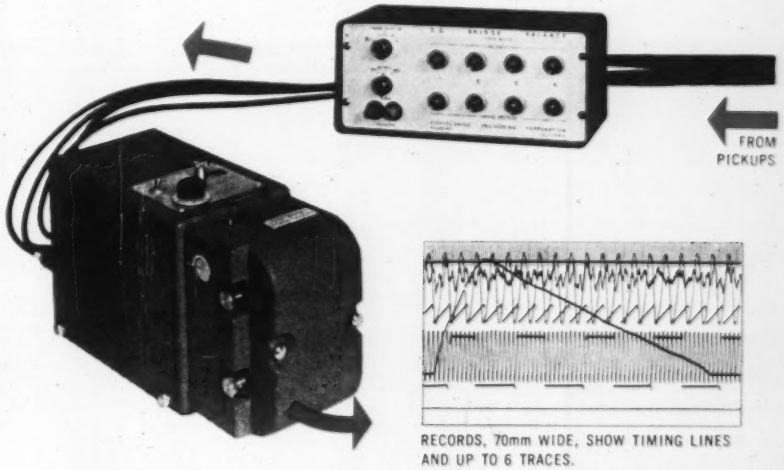
CANNON ELECTRIC CO., 3209 Humboldt St., Los Angeles 31, California. Representatives and distributors in all principal cities

For more information circle **158** on inquiry card.

To test your product dynamically...

here's a new high in flexibility... a new low in cost

This simplified, low-cost test equipment should be in every engineering department. It fills the long-standing gap between pen-type recorders and complex oscillograph/amplifier systems . . . provides a high-speed graphic record of the physical conditions that affect the life of your product. Stress, strain, pressure, vibration, temperature . . . you can measure them all *at the same time*. And these small, lightweight instruments can be carried anywhere . . . little experience is required for their operation.



RECORDS, 70mm WIDE, SHOW TIMING LINES AND UP TO 6 TRACES.

5-117 RECORDING OSCILLOGRAPH . . . records up to 6 channels of data *without amplifiers* at frequencies to 200 cps (with amplifiers, to 3000 cps). Uses 70-mm by 100-ft paper or film, driven ¾" to 24"/sec. Timing lines appear every 1/100 second. Bulletin CEC 1533A-X 12.

8-110 STRAIN-GAGE BRIDGE BALANCE . . . 4-channel control link between oscillograph and strain gages or resistance-type pickups. Has controls for balancing and adjusting d-c voltage across each channel and provision for calibration resistor. Send for Bulletin CEC 1560-X 7.

Consolidated Engineering

Corporation

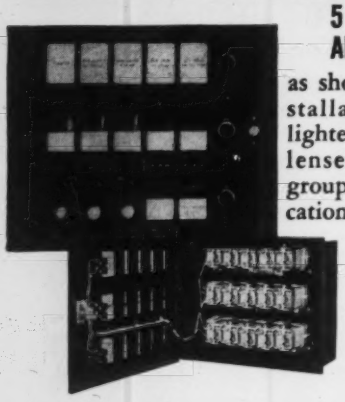
ELECTRONIC INSTRUMENTS FOR MEASUREMENT AND CONTROL

300 North Sierra Madre Villa, Pasadena 15, California

Sales and Service Offices Located in: Albuquerque, Atlanta, Boston, Buffalo, Chicago, Dallas, Detroit, New York, Pasadena, Philadelphia, San Francisco, Seattle, Washington, D. C.

For more information circle **159** on inquiry card.

TEL-ALARM offers



5 TYPES OF VISIBLE ALARM INDICATIONS

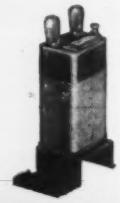
as shown in this typical installation. Includes backlighted nameplates, turret lenses and bullseyes, all grouped for quick identification.

4 SEPARATE CIRCUIT SEQUENCES

as used in this uniform assembly of the Relay Plug-Ins and Chassis.

SELF-CONTAINED TEL-ALARM PLUG-IN-UNIT

is a marvel of efficiency for alarm signal service. Over 100 variations in Circuit Sequences are possible in one uniform plug-in unit.



FOR FULL INFORMATION REQUEST BULLETIN 440

Tigerman Engineering COMPANY
4332 North Western Avenue
Chicago 18, Illinois

For more information circle **160** on inquiry card.

Lasico UNIVERSAL PLANIMETER

Here is the only Planimeter offered which averages the square root of all the differential pressures recorded on any square root circular chart. Inserts are calibrated for any make or size of flow meter thus eliminating the need for individual Planimeters. Improved optical target eliminates parallax which assures accuracy.

The Lasico Planimeter can also be supplied for use with linear graduated charts.

Send us your sample charts and let us give you a quotation.

LOS ANGELES SCIENTIFIC INSTRUMENT CO.
2451 Riverside Drive **Los Angeles 39, Calif.**

For more information circle **161** on inquiry card.

cam is installed; allows other than straight-line raising or lowering of variable.

3. *Pneumatic Time-Pattern Transmitters.* Same as cam programmer with pneumatic transmitter for supervision of remote processing. (*From new 24-page Bulletin* 1130, *"Program Control of Process Variables, Minneapolis-Honeywell Reg. Co., Ind. Div., Phila., 44, Pa.*)

For this literature circle **503** on inquiry card.

Zirconium

"Facts About Zirconium" is designed to set forth in concise form, the best available information about the new metal zirconium. Presently playing an important role in atomic energy applications, zirconium is fast becoming an important factor in chemical and metallurgical fields.

The Carborundum Metals Company, Inc., a subsidiary of The Carborundum Company, manufactures pure zirconium and hafnium in the first completely integrated commercial plant designed and constructed for this purpose.

Zirconium metal combines two outstanding characteristics—low neutron absorption and high corrosion resistance. Carborundum's scientists and engineers are exploring the possible commercial uses of zirconium and its compounds. (*From new 68-page booklet, "Facts About Zirconium," The Carborundum Metals Co., Inc., Akron, N. Y.*)

For this literature circle **504** on inquiry card.

Magnetic Potentiometer Standard

Loss of measurement and control during standardization periods can never be experienced with the constantly balancing G-E system. This is particularly significant for fast-reacting processes, where even a momentary lapse of control will have adverse effects on the quality of the product under process.

By eliminating the conventionally used dry cell, slidewire, and moving contacts—the magnetic standard does

GRAY INSTRUMENT CO.

PORTABLE MILLIVOLT POTENTIOMETER WITH LABORAORY ACCURACY
MODEL-E-3045-DVSG

DOUBLE RANGE O-16.1 M.V. & O-80.5 M.V. ON 15 PT. SWITCH & 220 DIVISION, SLIDE-WIRE SCALE

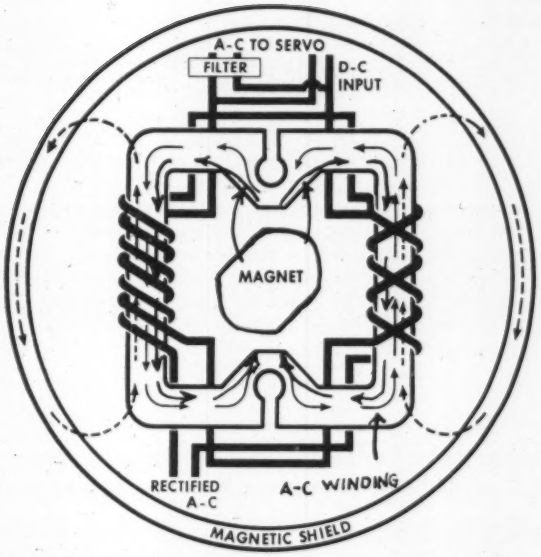
COMPENSATOR, O-1 M.V. & O-5 M.V. SET ON MAIN SCALE, TO MAIN SCALE ACCURACY

SPOT-LIGHT GALVANOMETER, SENSITIVITY 3 MICRO-VOLTS PER DIVISION.

ACCURACY, .01 M.V. ON LOW RANGE .05 M.V. ON HGH RANGE

WRITE FOR BULLETIN E-18
64 W. JOHNSON ST.
PHILA. 44, PA.

For more information circle **223** on inquiry card.



away with loss of accuracy and precision which often results from: (1) changes in the reference voltage due to the effects of ambient and humidity variations on the battery; and (2) changes in the contact resistance as moving contacts wear against the slidewire.

The Magnetic Standard consists of a thin steel lamination with a rotatable permanent magnet placed between the two central poles. Each outer leg has two windings. One is connected to a 16-volt half-wave rectified a-c source. The other winding carries a 0-5 ma d-c output from the balancing amplifier.

The a-c winding current varies the permeability of the steel lamination. This winding creates a flux path as shown by the (solid) flux pattern. The d-c windings are wound to produce a flux as shown by the (dotted) flux lines. The

STANDARDS

ENGINEERS

for Primary Standards and Instrumentation

At Hughes we are conducting fundamental research and development and production engineering in the fields of radar systems, guided missiles, digital and analog computers, microwave tubes, semiconductor products and other activities requiring use of many types of test equipment.

Those with extensive experience in the calibration and maintenance of precision electronic and electromechanical test equipment—with emphasis on measurement of electrical quantities to very close tolerances—will find satisfying outlets for their abilities in this work at Hughes.

HUGHES | *Scientific and Engineering Staff*

RESEARCH AND DEVELOPMENT LABORATORIES

Culver City, Los Angeles County, California

For more information circle **163** on inquiry card.

HIGH SPEED MICRO-DRILLS

STARTING FROM .0016"

"IN STOCK"!

Precision micro-drills for small holes. Sizes from .04 mm (.0016") to 1.0 mm (.040") in increments of .01 mm (.0004"). These precision drills are available in two styles, flat pivot drills or spiral fluted drills. Center drills for micro-drilling also available from stock. They are all made with concentric oversize shanks. Because of their extreme rigidity they are especially useful in all types of drilling equipment.

Send for Bulletin "P" listing sizes and prices of stock drill sizes and micro-drilling equipment.

Sphinx brand micro drills used throughout the world for many years for all fine watch and instrument work.

LEVIN®

LOUIS LEVIN & SON, INC.

3610 South Broadway · Los Angeles 7, Calif.

For more information circle **162** on inquiry card.

PD METER

UP TO 12"

WITH THE OVAL WHEEL METER (P.D. METER)

BOPP & REUTHER G.M.B.H.

MANNHEIM-WALDHOF · GERMANY

REPRESENTED IN USA BY HEINZ W. HOPF

527 LEXINGTON AVE

NEW YORK 17, N.Y.

For more information circle **164** on inquiry card.

MARSH QUALITY

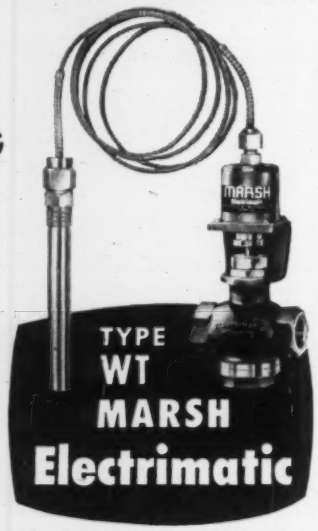
. . . in a Temperature-actuated

REGULATING VALVE

Smooth, modulating control

— for brine lines in cooling systems

— for condensers where pressure line is not desired



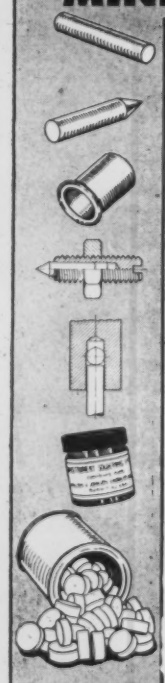
A temperature actuated regulating valve you can depend on—the Marsh Electrimatic Type WT for pressures up to 150 psi, water or brine, and up to 15 lbs. for steam (250° maximum temperature). It opens as temperature rises, closes as temperature falls, to give an ideal, smooth, modulated control. Can be mounted in any position; serviced without breaking connections. Seat beads are monel to eliminate wire drawing. Sturdy, two-ply bellows assures extra service life. Temperature ranges of 20°F.-60°F.; 60-100, 100-140, 140-180, 160-220. All standard sizes from ⅜" through 4". All styles of temperature bulbs.

Ask for latest data

MARSH INSTRUMENT CO. *Sales Affiliate of Jas. P. Marsh Corp.* Dpt. 42, Skokie, Ill.
Marsh Instrument & Valve Co. (Canada) Ltd., 8407 103rd Street, Edmonton, Alberta, Canada

For more information circle **165** on inquiry card.

MINIATURE PARTS



CUSTOM MANUFACTURE OF SMALL PARTS

• Shafts, Staffs and Pivots of Special Pivot Steel, Heat-Treated and Metallographic-Polished. • Tubular Products up to ⅜" Diameter, Cut, Flared, Swaged, Formed and Burr-Free Alloy or Silver Plated. • Screw-Machine Products up to 3/16" Diameter. • Roll-Threading and Knurling to Close Tolerances. • Centerless and Surface Grinding with Special Facilities for Ceramic Rods and Shapes. • Light Punch-Press Work.

SERVICES FOR CUSTOMERS' PARTS

• A Multitude of Services are Available for Customers' Parts at Any Stage of Manufacture. These Include: Controlled-Atmosphere Heat-Treating, Centerless Grinding, Surface Grinding, Knurling, Thread-Rolling, Swaging, Drilling, Milling, Burr Removing, Metallographic, Polishing, Barrel-Plating in Alloy or Silver.

ASSEMBLY SUPPLIES

• "Welton" Non-Corrosive Instrument Solder Paste. • "Weltonoil" Treated Button-wood Pith.

APPARATUS DESIGN SERVICES

In Connection with the Design and Fabrication of Precision Miniature Parts.

ENGINEERING ASSISTANCE ON ALL ITEMS

Welton V. Johnson
ENGINEERING COMPANY INC.
87 SUMMIT AVENUE • SUMMIT, N. J.

For more information circle **166** on inquiry card.

BRIEFS—CONTINUED

flux in the outer legs, caused by the magnet, is in the opposite direction to that caused by the d-c winding.

At some position of the magnet its magneto-motive force will be equal and opposite to that of the d-c winding in the outer leg. At any other position a net flux will (occur) . . . This net flux changes in magnitude due to the varying permeability of the lamination and thus induces an a-c error voltage in the d-c windings. This a-c voltage is filtered, amplified, and causes the servo motor to move the magnet and the pen & pointer to a new position reducing the net flux to zero. This causes the system to be in balance. This balanced condition indicates the new output of the primary element. (*From 20-page brochure GED-2100A, General Electric, Schenectady 5, N. Y.*)

For this literature circle **505** on inquiry card.

Spectrophotometry

The Model 11 monochromator is a double mirror-collimated Littrow type with two 30° quartz prisms (F) and (K) selected for high ultraviolet transmission. The aperture of the monochromator is 3.75 cm in diameter; the focal length is 41 cm, and the slit height is 2.0 cm . . . Light sources are a water cooled, high intensity hydrogen arc (A') and a tungsten lamp (A).

The phototubes are specially selected in matched pairs. 1P28 phototubes having a useful range from 2100 to 6000 Angstroms are regularly supplied. Special phototubes sensitive to longer wavelengths may also be supplied on special order.

The photometric system operates on a null balance principle. One of the 60 cps modulated exit beams of monochromatic radiation passes through the reference absorption cell and then falls on one of the phototubes; the other beam passes through the sample cell and onto the other phototube. A fraction of the reference phototube signal, as determined by the slidewire position, balances the signal at the sample phototube. Any unbalance at this point is further amplified and causes the pen motor drive the slide-

make

Kenyon

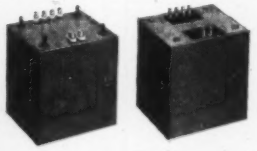
your source

of supply

for special

and standard

transformers



TWINS

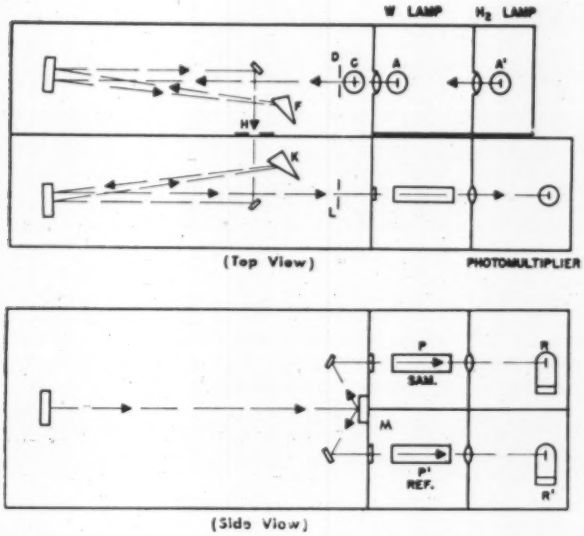
The Kenyon Twins solve all problems for those who must meet rigid specifications.

- **ML meets all MIL-T-27 requirements.**
- **CL meets all civilian requirements.**
- **Electrically identical — Mechanically interchangeable.**
- **Contain Best Class A Wire and Insulation available.**
- **Finished in smooth, durable, medium gray (other colors if desired).**
- **Completely Hermetically Sealed.**

WRITE FOR CATALOG

Kenyon
TRANSFORMER CO., INC.
840 Barry Street, New York 59

For more information circle **167** on inquiry card.



wire contact toward the balance point. (*From new* 16-*page Brochure SB*1, *Applied Physics Corp., Pasadena, Calif.*)

For this literature circle **506** on inquiry card.

DIVIAC

The DIVIAC is a transducer for translating shaft rotation to an electrical analog with linearity of 0.02 percent, resolutions of 0.005 percent. It is essentially an automatized Kelvin-Varley circuit. The input voltage is placed across eleven matched resistors, giving an input resistance of 11R. Brushes a and b (Figure 1) are across two re-

When you need a **Non-Stock Pot** ask

HELCO

PRODUCTS CORPORATION

Manufacturers of

Ultra High Precision Potentiometers

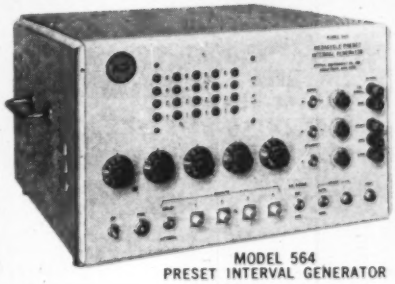
2041 COLORADO AVE.

SANTA MONICA, CALIF.

For more information circle **169** on inquiry card.

DIGITAL

PRESET INTERVAL GENERATOR



MODEL 564
PRESET INTERVAL GENERATOR

EXACT DIGITAL SELECTION

•

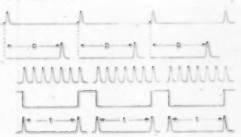
NO CALIBRATION REQUIRED

•

SINGLE RANGE, 100,000 STEPS

The "PIG" will —

- GENERATE DELAYS
- GENERATE PULSE BURSTS
- GENERATE VOLTAGE GATES
- MEASURE TIME INTERVALS



- Internal 1 megacycle crystal oscillator time base
- Accepts any external time base up to 1 megacycle
- Fast reset—recycles in 50 microseconds
- Independent and simultaneous outputs
- Preset counter up to 1 megacycle

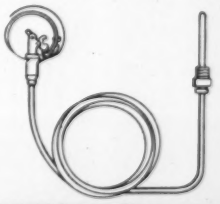
For complete information, write or call

Potter POTTER INSTRUMENT COMPANY, INC
115 Cutter Mill Road • Great Neck, N. Y.

For more information circle **168** on inquiry card.

Quality SMALL TUBING in COPPER and COPPER BASE ALLOYS

★ THIN WALL Tubing
★ BRAIDED Tubing
★ CAPILLARY Tubing
★ BOURDON Tubing
★ SHAPE Tubing



For *better* measurement and control in Industrial Instruments

Since 1909 we have specialized in the manufacture of seamless bourdon and capillary gauge tubing for instruments, gauges, pressure control and recording equipment, and for applications requiring tubing of accurate gauge and fine finish.

Years of manufacturing experience, plus modern mill equipment, rigid production and laboratory control assure both excellence and uniformity in every foot of tubing for maximum production and efficiency.

THE MACKENZIE WALTON CO.
PAWTUCKET • RHODE ISLAND

Write for Catalog MW-A

SALES REPRESENTATIVES

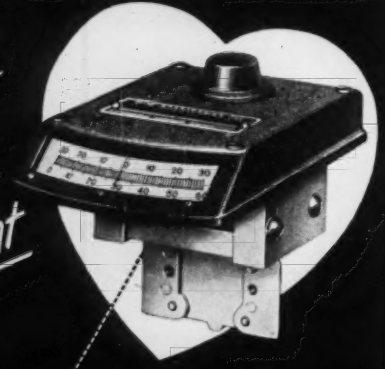
BALTIMORE, MD.	CHARLES R. ROBISON, 23 E. 25th St.
CHICAGO, ILL.	COREY STEEL CO., 2800 So. 61st Court
NEW YORK, N. Y.	JOHN J. CONDON Inc., Ozone Pk., N.Y.
PHILADELPHIA, PA.	DAVID C. CLEM, 1420 Walnut St.
ROCHESTER, N. Y.	WILLIAM A. OLSON, 520 Granite Bldg.

For more information circle **170** on inquiry card.

Make a GM PORTABLE D'ARSONVAL

GALVANOMETER

the Heart of Your Instrument



FOR MEASURING LIGHT reflectance and color, the Photovolt Corporation of New York uses a Model 600 G-M Galvanometer for its popular Reflection Meter (left). Whatever your own particular instrument field, you can achieve this same self-contained portability, ruggedness and high sensitivity with G-M Galvanometers. Complete catalog on request.

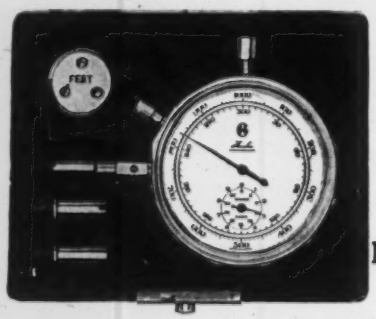
GM LABORATORIES · Inc.

4316 NORTH KNOX AVE., CHICAGO 41

For more information circle **171** on inquiry card.

HASLER SPEED INDICATOR

Chronometric Tachometer with separate reset button for cumulative readings



Accurate
Automatic
Durable
Flexible
Portable
Non-magnetic

Size
2¾" x ⅞" x 4"
Spindle incl.

Weight
7¾ oz.
ready for test

Type A 0 20,000 r.p.m.
or 0 6,000 f.p.m.
Type B 0 2,000 r.p.m.
or 0 600 f.p.m.

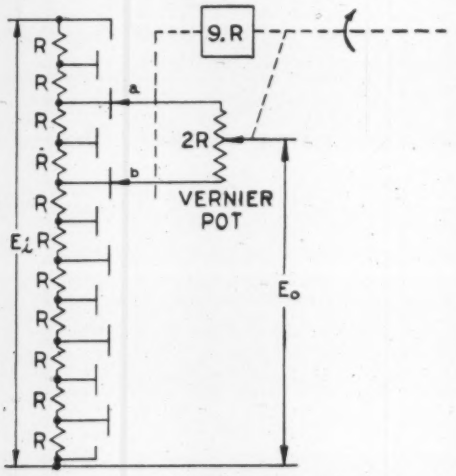
Shipment within 5 days from stock

To order:
Type A-1 0-30,000 r.p.m.
All instruments serviced by

HASLER—TEL COMPANY,
28 Vesey Street, New York 7, N. Y.
U.S. Distributors for Hasler Speed Indicators since 1919

For more information circle **172** on inquiry card.

BRIEFS—CONTINUED



sistors and connect a vernier pot having a resistance of 2R across 2R. Then the resistance from a to b is 2R in parallel with 2R which is R. This gives the bank an equivalent resistance of 10R. Then as the brushes move from top to bottom, the input voltage is divided into 10 equal steps. Across brush a-b will be Ei, .9Ei, .8Ei, etc. The vernier pot further sub-divides the voltage to give a linear voltage vs. rotation curve. The switching is accomplished in such a manner that the point where the vernier pot wiper is positioned does not change voltage thus making the switching uncritical. (*From new 4-page brochure, Feedback Controls, Inc.*, 1332 *N. Henry St., Alexandria, Va.*)

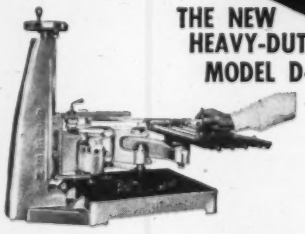
For this literature circle **507** on inquiry card.

unique in design — rugged in construction

GREEN PANTOGRAPH ENGRAVERS

THE FAMOUS MODEL 106

THE NEW HEAVY-DUTY MODEL D-2



The three-dimensional bench Model 106 cuts costs — engraves, routs, models and profiles, giving you expert results even by unskilled workers.

The Model D-2 two dimensional heavy-duty Pantograph is a precision machine with a multitude of new features. Open on three sides, it permits complete freedom for engraving, milling, profiling large panels (up to 30" in diameter) or bulky pieces. Single, micrometer adjustment controls vertical depth of cut, automatically adjusting copy table with pantograph. Range of reduction ratios from 2-to-1 to infinity! Vertical range over 10 inches!

For complete information, write to

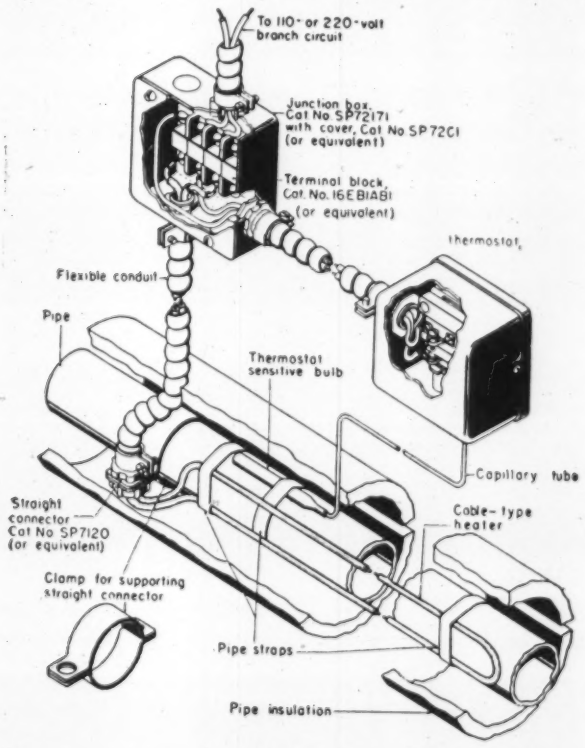
GREEN INSTRUMENT COMPANY
383 Putnam Ave. Cambridge, Mass.

See us at Booth 548, Production Engineering Show, Navy Pier, Chicago

For more information circle **173** on inquiry card.

Pipeline Heating

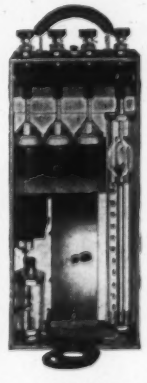
In many systems of fuel oil piping it is necessary to provide an economical method of maintaining a minimum fuel oil temperature in the lines during shut down or out of service periods. . . . Low temperature electric heating

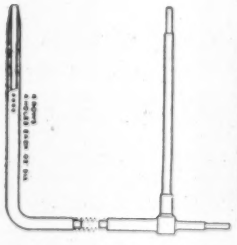

To 110- or 220-volt branch circuit
Junction box, Cat No SP7217I with cover, Cat No SP72CI (or equivalent)
Terminal block, Cat. No. 16E B1ABI (or equivalent)
Thermostat
Flexible conduit
Pipe
Thermostat sensitive bulb
Capillary tube
Straight connector Cat No SP7120 (or equivalent)
Cable-type heater
Clamp for supporting straight connector
Pipe straps
Pipe insulation

Rule Out Guesswork!

Portable and stationary Inclined and Vertical Draft Gages. Level and tube replaceable in field. Constant zero. Bulletin 109.

Air Filter Gages for measuring resistance in air conditioning ducts. Bulletin 114.





Be Sure with ELLISON Instruments

Pitot Tubes for air and gas flow measurements. Angle and straight stem types, brass for temperatures to 500°F., stainless steel for temperatures to 4000°F. Bulletin 109.

PORTABLE GAS ANALYZERS Accurate, easy to use Combustion Testing Set equipped for analysis of CO_2, O_2 and CO, complete with flue gas thermometer. Bulletin 120.

ELLISON DRAFT GAGE CO.

546 W. MONROE ST. Since 1896 CHICAGO 6, ILL.

THE ELLISON LINE ALSO INCLUDES:

Straight-Line & Dial Draft Gages • Inclined Draft Gages—Portable Inclined Vertical Tube Gages • Vertical Tube Gages—Oil, Heavy Liquid and Mercury—Single and Multi-Tube • Saturator Gages • U Gages—Stationary and Portable • Air Filter Gages—Dial and Inclined Tube Types • Pitot Tubes • U Path Steam Calorimeters • Portable Gas Analyzers—Orsat Type

For more information circle **174** on inquiry card.

Your mechanisms will run smoother, last longer, give better service and satisfaction with WINZELER *Stamped* Gears. You can avoid costly downtime too, because of greater accuracy and uniformity. We mass-produce Stamped Gears and Segments from any material with remarkable skill and precision. Some are laminated, indexed and assembled, to cut costs for many unusual applications. Stock dies available. Tell us now, about your needs.

SEND FOR *4-page folder containing valuable Stamped Gear data and tables. Write today!*

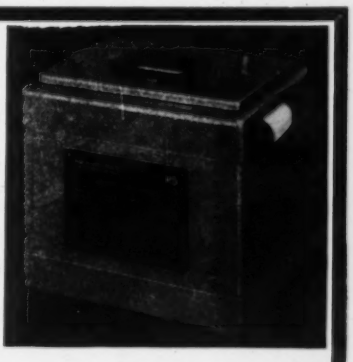
WINZELER *Stamped Gears*

WINZELER MANUFACTURING & TOOL CO.

1712 WEST ARCADE PLACE, CHICAGO 12, ILLINOIS

For more information circle **175** on inquiry card.

H & B 4-channel High Speed PHOTO-TRACE RECORDER



"Lumiscript" RLt 4

- **Instantly visible recording** on a special photographic tape which need not be developed.
- **Wide selection of measuring movements** available with inherent frequencies from 1 up to 570 cps.
- **Up to 4 measuring movements** can be installed in one instrument.
- **Push-button action** allowing 3 speeds.
- **Sensitive** to a speed up to 400" per sec.

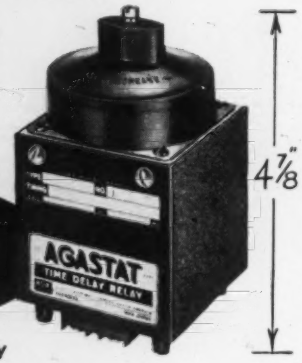
Write for complete literature and prices.

EPIC inc.

154 Nassau Street New York 38, N. Y.

For more information circle **176** on inquiry card.

Time delays in automation circuits



AGASTAT

Time / Delay / Relay

When automatic machinery and circuits must be timed with repetitive accuracy (from 0.1 second to ten minutes or more) you'll find a sure, reliable answer in AGASTAT electrically-actuated pneumatically-timed time delay relays.

The AGASTAT is
- light, versatile, dependable.
- unaffected by voltage variations.
- instantaneous recycling.
- available in models which offer delays on energizing and de-energizing, two-step delays, manually-actuated time delay switch, remote push button control.

WRITE **our application engineers for help with your timing problem. Address Dept. A23-89.**

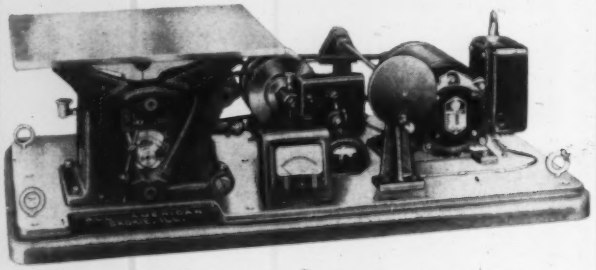
AGA DIVISION

Elastic Stop Nut Corporation of America

1027 Newark Avenue, Elizabeth, New Jersey
Pioneers in pneumatic timing.

For more information circle **177** on inquiry card.

New, All American Model 150 VA-D Vibration Fatigue Test Machine Handles Large Assemblies Or Parts, Up To 150 Lbs.



This new addition to the All American line of vibration fatigue test machines produces vibration vertically in simple harmonic motion. Parts or equipment, up to 150 lbs. in weight are subjected to thorough, accurate vibration fatigue test. Machine has a 50% overload factor. Sturdy anti-friction mechanism. Load on table is carried on strudy "V" frames. Range selector (automatic frequency control) changes acceleration automatically from 10 to 60 cycles per second and back, or any choice of cycles within that range. After finding critical vibration point, frequencies can be held there to determine final breakdown of part being tested.

Recommended for testing aircraft, electrical, electronic, ordnance, automotive, projection and optical equipment. Send for Catalog F which describes All American Vibration Fatigue Test Machines, contains helpful data, nomograph chart, and lists typical users. Write to All American Tool & Mfg. Co., 8011 Lawndale Ave., Skokie, Ill.

For more information circle **178** on inquiry card.

BRIEFS—CONTINUED

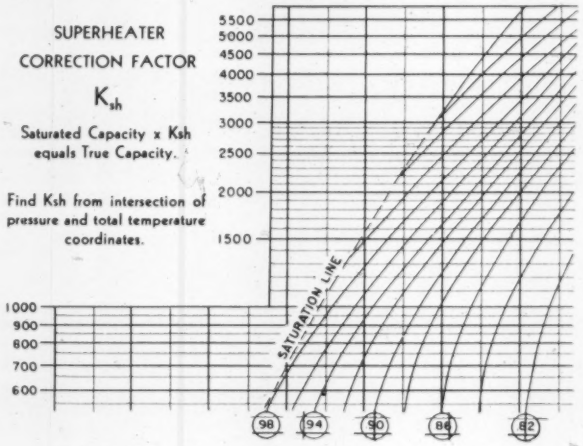
cable applied directly to the outside of the finished piping system and thermostatically controlled, answers all the requirements. (*From new 32-page Bulletin* 1600-*A, Preferred Utilities Mfg. Corp.*, 1860 *Broadway, N. Y.* 23, *N. Y.*)

For this literature circle **508** on inquiry card.

High-capacity Safety Valves

Ordering information for safety valves for boiler installation under ASME Power Boiler Code:

Determine the required orifice from the capacity tables or the formula W = 45APKsh (where) W = Lbs. steam



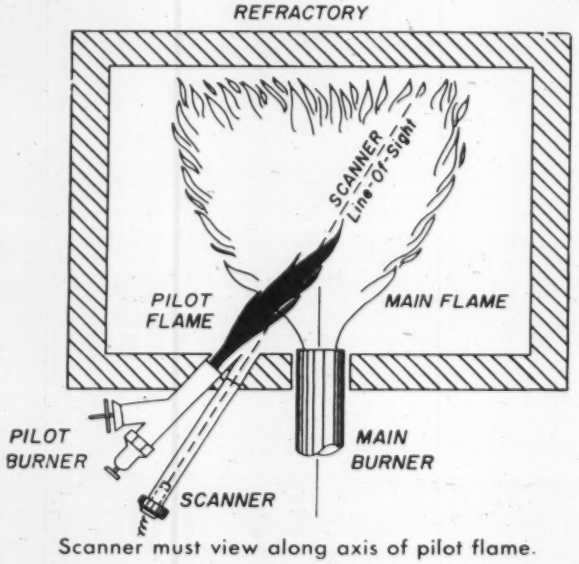
per hour (ASME 90 percent rating); P = set pressure × 1.03 + 14.7; A = orifice area, sq. in.; Ksh = superheat correction factor.

The chart of Superheat Correction Factor (Ksh) shows Ksh at any given pressure and total steam temperature. Saturated capacity × Ksh equals true capacity. (*From new* 16-*page Catalog* 400-*HC, Crosby Steam Gage & Valve Co., Wrentham, Mass.*)

For this literature circle **509** on inquiry card.

Combustion Safeguard

Fireye System FJ-2 provides complete automatic starting and operating flame failure protection for commercial light oil, gas, and combination light oil/gas burners. It uses the "Firetron" lead sulfide cell, which visually detects



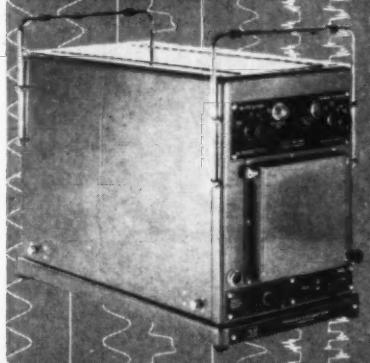
Scanner must view along axis of pilot flame.

BRINGS A NEW CONCEPT INTO THE FIELD OF SIMULTANEOUS MULTIPLE MEASUREMENT

direct writing

TYPE 550-A

OSCILLOGRAPHIC RECORDER



DC TO 900 CYCLES

A New High in Frequency Response For Direct Writing Oscillographs!

MULTI-CHANNEL: EIGHT SIMULTANEOUS TRACES

applicable to inquiry into:

- GEOPHYSICAL EXPLORATION
- MEDICAL AND BIOLOGICAL RESEARCH
- VIBRATION STUDIES
- ACCELERATION TESTING
- STRAIN EVALUATION
- SHOCK TUBE INVESTIGATIONS
- EVENTS SEQUENCE RECORDING
- DETONATION MEASUREMENTS
- PERCENT FACILITY UTILIZATION
- WELDING ANALYSIS
- BLOW-DOWN TUNNEL WORK
- HYDRODYNAMIC TESTING

Write *today* for your copy of our Bulletin 1-102

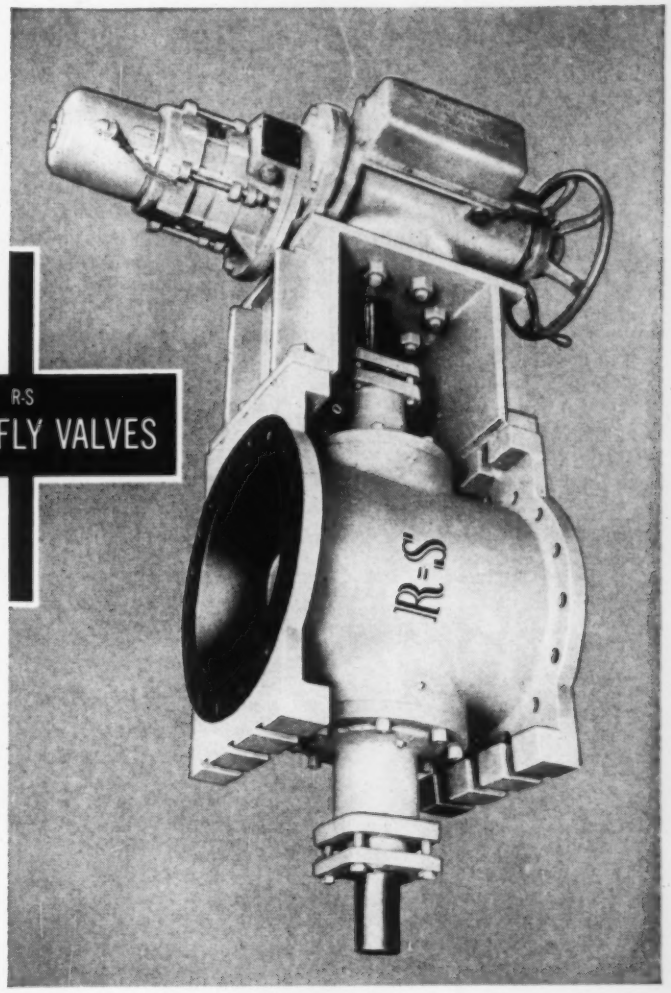
TECHNOLOGY INSTRUMENT CORP.

557 Main Street, Acton, Mass. COlonial 3-7711
P. O. Box 3941, No. Hollywood, Calif. POplar 5-8620

Visit us at the WESCON Show Booth 1113

For more information circle **179** on inquiry card.

R-S BUTTERFLY VALVES



SPECIAL R-S VALVES RESIST CORROSION...ABRASION...HEAT

Where rugged processing conditions call for special handling, R-S Butterfly Valves are designed and built to meet individual requirements. Any type of metal or other material that can be cast or welded—even plastics—may be specified for valve bodies or parts.

Special metals have been developed to withstand corrosion, abrasion, erosion, high heat and pressure. For certain types of corrosion, the R-S Rubber-lined Valve may be used. Every R-S Valve gives you the advantages of quick and positive closure with any type of controls, uniform control in normal regulating range, and minimum pressure drop to save power.

When past experience offers no precedent, you can draw on our background in specialized valve engineering to solve material problems. To find the proper valve for any application, or for full information on our full line of butterfly, cone and ball valves, write to S. Morgan Smith Company, York, Pennsylvania.

Hydraulic Turbines | Gates & Hoists
Pumps | Trash Rakes
Accessories

HYDRODYNAMICS

Rotovalves | Free-Discharge Valves
Ball Valves
Butterfly Valves | Controllable-Pitch Ship Propellers

S. MORGAN SMITH CO.

AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED, TORONTO

For more information circle **180** on inquiry card.

CRAMER TIME TOTALIZERS

- *Electrical Stop Clocks*
- *A complete line of Running Time Meters*

Wherever time must be accurately measured and accumulated. Write for Bulletin PB-610.

Cramer TIMING DEVICES

SPECIALISTS IN TIME CONTROL

The R. W. CRAMER CO., *Inc.*

BOX 5, CENTERBROOK, CONNECTICUT

CR55

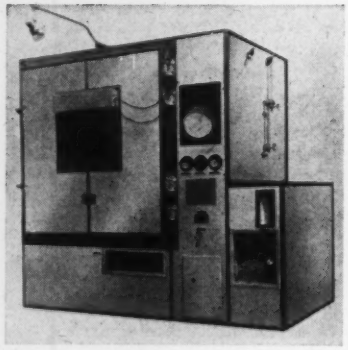
For more information circle **181** on inquiry card.

DEVELCO

SALT SPRAY FOG TEST CHAMBERS

To Meet
MIL-E-5272
And Others

- **Top Opening**
- **Front Opening**
- **Walk-In**



Write for Bulletin SS55

DEVELOPMENT ENGINEERING COMPANY

9 CROSS ST. NORWALK, CONN.

MFRS. OF ENVIRONMENTAL TEST EQUIPMENT
FUNGUS TESTING—COLD—HEAT—ALTITUDE—HUMIDITY

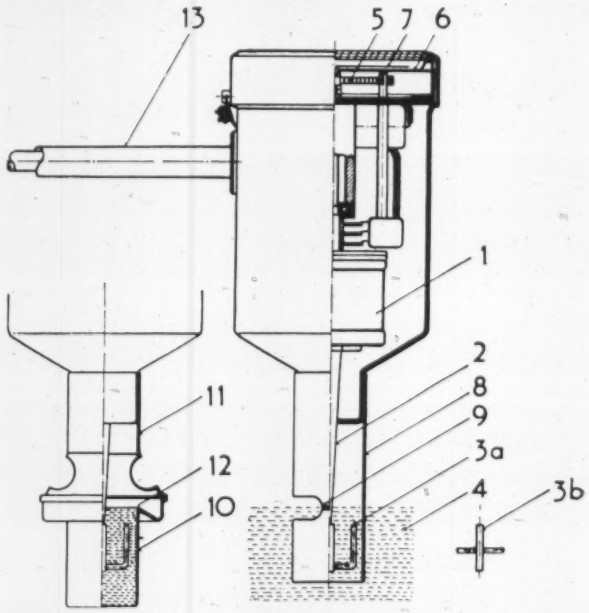
For more information circle **182** on inquiry card.

both gas and oil flames. Resistance of the cell varies when it "sees" infrared radiation. The electronic circuit amplifies only the pulsating frequency peculiar to flame radiation. The system thus easily discriminates between flame and hot refractory or other source of infrared. The single Type 48PT1 Scanner supervises both pilot and main flames. The system does not allow the main fuel valve to open unless the pilot flame has been established. Where direct electric spark ignition is used, the control provides a five second trial-for-ignition period. (*From new* 16-*page Installation Bulletin CF-30, Combustion Control Div., Electronics Corp. of America,* 718 *Beacon St., Boston* 15, *Mass.*)

For this literature circle **510** on inquiry card.

The Drage Viscometer

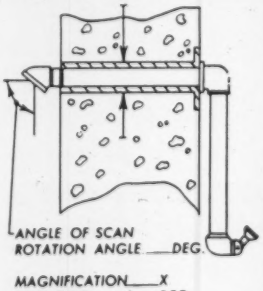
In the Drage viscometer a synchronous motor drives an interchangeable measuring element (3) . . . dipped into the substance to be tested. The frictional forces which act



on the measuring element are linearly related to the viscosity. These forces are transmitted to the rotateably mounted motor; the torque is opposed by the precision spring (5) . . . Depending on the measuring element used, the same instrument can be used to measure viscosities from 0.2 to 30,000 centipoises. The range can be extended to beyond 100,000 cp. in certain cases. (*From new* 8-*page brochure, "Drage* 15," *Drage Products,* 406 32 *St., Box* 330, *Union City, N. J.*)

For this literature circle **511** on inquiry card.

Industrial Periscopes

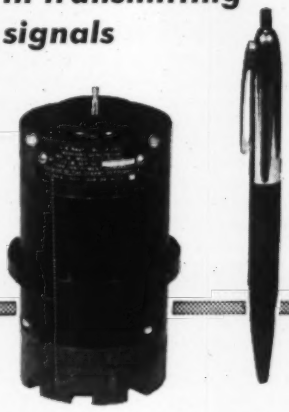


Whenever processes must be observed or controlled in the presence of heat, water, or harmful radiation, the use of industrial periscopes should be considered by the plant designer . . . Industrial periscopes may range in size from that of a small borescope to one even larger than the giant instruments which are the eyes of our submarines.

Factors to consider include: (1) location of viewing head, (2) location of eyepiece, (3) body tube, (4) magnification, (5) field of view, and (6) scanning. (*From new* 4-*page Bulletin* 301, *Kollmorgen Optical Corp.,* 30 *Church St., N. Y.* 7, *N. Y.*)

For this literature circle **512** on inquiry card.

Telesyn®
SYNCHROS
from FORD INSTRUMENT
for extreme accuracy in transmitting signals



STANDARD TELESYN SYNCHROS
are available from Ford Instrument in

Size 1	Size 3
Size 5	Size 23

for EARLY DELIVERY

A pioneer in the field of synchronous transmission, Ford Instrument produces synchros of proven precision accuracy.

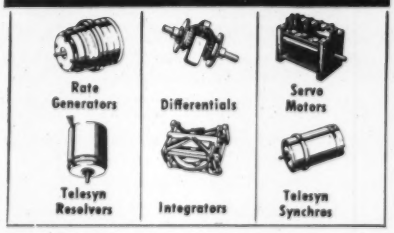
- **Available to meet Mil specs**
- **In sizes to meet a multitude of requirements**
- **For torque transmission and voltage indication**

FREE a fully illustrated technical data bulletin gives characteristics and specifications. Please address Dept. IA.

43

FORD INSTRUMENT COMPANY
Division of Sperry Rand Corporation
31-10 Thomson Ave.
Long Island City 1, N. Y.

Ford Instrument's standard components



For more information circle **183** on inquiry card.

SIE
MODEL E-2

COMPARISON BRIDGE

for fast, accurate matching and measuring of

RESISTORS 1 ohm to 5 megohms

CAPACITORS 500 mmfd to 2000 mfd

INDUCTORS 3 millihenrys to 10,000 henrys

Sloping meter face and wide-spaced component clips speed production line testing. Foot operated switch* allows two-hand operation.

Stable, high-gain, circuit permits the detection of component differences amounting to only 1 part in 10,000. Five meter ranges indicate differences at 1%, 2.5%, 10% and 25% value full scale.

In the design laboratory, or in assembly operations, the E-2 Comparison Bridge offers accuracy, flexibility, and dependability.

★ **EASY TO USE—**
Spring clip, and banana-plug terminals.

★ **HAND OR FOOT OPERATED—**
*Foot control optional at extra cost.

★ **ACCURATE—**
Tolerance 0.1% on 1% scale.

SIE

★ **LOW COST—**
$185 FOB Houston.

SOUTHWESTERN INDUSTRIAL ELECTRONICS CO.
INDUSTRIAL INSTRUMENT DIVISION
P. O. Box 13058 2831 Post Oak Road Houston, Texas

205-55 REPRESENTATIVES THROUGHOUT THE WORLD

For more information circle **184** on inquiry card.

New Literature...

INSTRUMENTS and AUTOMATION

For literature use the postage-free order card on page 1373.

AUTOMATION

Industrial Program Control. New 24-page Bulletin 1130 "Program Control of Process Variables" describes methods and advantages of employing automatic, time-conditions control for industrial processes and tests.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **513** on inquiry card.

Positioning Relay, Transmitter. New 4-page Specification Sheet P99-5 describes maker's positioning relay used to convert any position-type signal into a proportional pneumatic signal for control purposes.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

Circle **514** on inquiry card.

Process Controllers, Recorders. New 8-page issue of "Modern Precision" (Vol. 15, No. 1) features article on "Speedomax" recorders used at the Canadian National Research Council; also uses of maker's "Speedomax" recorders and process controllers in induction heating, power generation, waste treatment, etc.—Leeds & Northrup Co., 4907 Stenton Ave., Philadelphia 44, Pa.

Circle **515** on inquiry card.

Process Instrumentation. Three new 2-page Data Sheets 7.0-6, 10.16-20 and 29.7-3 describes Milton Roy proportional-feed inhibitor injection system; "Wihtol" recording microphotometer; and "Deculator" paper-processing instrumentation.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **516** on inquiry card.

Cement Control. New 2-page Data Sheet 1.1-4 describes control of water percentage in wet process cement manufacture by use of Bendix Nuclear density gage with "Electronik" controller.—Minneapolis-Honeywell Regulator Co., Industrial Div., Philadelphia 44, Pa.

Circle **517** on inquiry card.

Sequencing Timing Control. New 4-page Data Sheet 11.12-1 describes maker's systems for obtaining sequencing timing control.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **518** on inquiry card.

Current Controllers. New 4-page Bulletin EB-1 describes maker's "Model EB" current controller, a pneumatic-electric transducer which provides automatic control of current for industrial applications.—Conoflow Corp., 2100 Arch St., Philadelphia 3, Pa.

Circle **519** on inquiry card.

Press Control. New 2-page Bulletin PC-2 describes maker's "Model PCE & PCM" press clearance controls that automatically detains press action until punched piece is removed.—Control Devices, Inc., 8299 E. Nine Mile Rd., Van Dyke, Mich.

Circle **520** on inquiry card.

Monitoring System. New 8-page descriptive Bulletin 3036A presents illustrations of maker's "Omniguard" indicating and alarm system for protection against excessive temperature in critical spots in bearings, gases and liquids.—Thomas A. Edison, Inc., Instrument Div., W. Orange, N. J.

Circle **521** on inquiry card.

Water System Control. New 4-page issue of "Autocon Rambler" (Vol. 7, No. 2) describes tankless systems giving efficient liquid distribution without storage tanks.—Automatic Control Co., 995 University, Saint Paul 4, Minn.

Circle **522** on inquiry card.

Water Plant Control. New 4-page issue of "Ratonews" (Vol. 4, No. 4) describes emergency portable chlorinators, homoginizers, flow-rate meters, etc., for use in water plants.—Fischer & Porter Co., Hatboro, Pa.

Circle **523** on inquiry card.

Carrier Signaling System. New 4-page Bulletin AF-554 describes maker's carrier signaling system for increasing capacity of signaling communications lines.—North Electric Co., Industrial Div., Galion, Ohio.

Circle **524** on inquiry card.

3-Position Indicator. New 4-page bulletin describes and illustrates hermetically-sealed 3-position indicator used as process monitor.—Keystone Watch Case & Instrument Div., The Riverside Metal Co., Riverside, N. J.

Circle **525** on inquiry card.

Beta-ray Control System. New 4-page issue of "Nucleonics Views" (Vol. 3, No. 2) features article on "Reversing Mill Automatically Controlled at Stanley Works."—Industrial Nucleonics Corp., 1205 Chesapeake Ave., Columbus, Ohio.

Circle **526** on inquiry card.

Material-handling Equipment. New 142-page Catalog 555 describes and illustrates maker's vibratory material-handling equipment and power tools. Includes automatic batching equipment, bin vibrators, concrete breakers, drills, vibrators, weigh feeders, weighing machines, etc.—Syntron Co., Homer City, Pa.

Circle **527** on inquiry card.

Machine Control. New 4-page illustrated bulletin describes maker's "SCI 200" electrical control system for predetermined repeat or non-repeat machine cycle.—Security Controls, Inc., 255 Franklin St., Buffalo 2, N. Y.

Circle **528** on inquiry card.

Photoelectric Control. New 4-page bulletin describes maker's "Registron" which automatically controls cutoff and color register on high speed, web-fed presses and other rotary printing equipment.—Champlain Co., Inc., 88 Llewellyn Ave., Bloomfield, N. J.

Circle **529** on inquiry card.

Exhibit Display Moving. New 12-page brochure "Display Moving Service" describes methods of moving exhibit displays and high-value products with minimum crating.—North American Van Lines, Inc., Exhibit Display Dept., Fort Wayne 1, Ind.

Circle **530** on inquiry card.

VALVES

Control-valves Handbook. New 72-page Catalog 305 describes, illustrates and presents specifications of maker's standard and special control valves and auxiliary equipment. Includes handbook-type appendix on valve principles—C_v, rangeability, etc.—Mason-Neilan Regulator Co., 1190 Adams St., Boston 24, Mass.

Circle **531** on inquiry card.

Solenoid Valves. New 20-page catalog illustrates and describes maker's line of electrically controlled magnetic valves for water, oil, brine, air, solvents, gas and steam.—Magnatrol Valve Corp., 67 Fifth Ave., Hawthorne, N. J.

Circle **532** on inquiry card.

Control Valves. New 42-page 1955 Catalog 608-179 presents specifications of maker's large line of industrial valves—magnetic gas valves, proportioning control gas valves, gas fuel governors, magnetic valves, etc.—General Controls, 801 Allen Ave., Glendale 1, Calif.

Circle **533** on inquiry card.

Solenoid Valve. New 2-page Bulletin V5001 presents applications and developments of maker's two-way midget packless valves.—Automatic Switch Co., 391 Lakeside Ave., Orange, N. J.

Circle **534** on inquiry card.

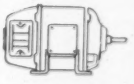
Reducing Valve. New 4-page Bulletin S-731 describes maker's "Type 345" high-pressure reducing and regulating valve for hydraulic presses, hydraulic systems die-mold apparatus, etc.—A. W. Cash Co., P. O. Box 551, Decatur, Ill.

Circle **535** on inquiry card.

Valve Positioner. New 2-page Bulletin F 5991-1 describes maker's "Throttltrol" automatic valve positioner used with any control instrument having a high and low contact with a neutral position.—Barber-Colman Co., Wheelco Instruments Div., Rockford, Ill.

Circle **536** on inquiry card.

SYNCHROS, MOTORS



Synchros, Resolvers. New 16-page Bulletin 362 presents specifications and characteristics of maker's synchros, servo motors, resolvers, tools and adapters.—Norden-Ketay Corp., 555 Broadway, New York 12, N. Y.

Circle **537** on inquiry card.

Motors. New 4-page bulletin presents diagrams on maker's basic mo-

tor frame designs.—Air-Marine Motors, Inc., 369 Bayview Ave., Amityville, L. I., N. Y.

Circle **538** on inquiry card.

Gear Motors. New 4-page bulletin presents data on maker's gear train-control motor combinations includes complete list of gear ratios available for sizes 9, 11, 15, and 18 control motors.—Transicoil Corp., Worcester, Montgomery County, Pa.

Circle **539** on inquiry card.

TEMPERATURE

Thermal Controls. New 52-page Catalog 400 describes proper applications of maker's "Thermoswitch" thermostats for heat control problems.—Fenwal, Inc., Ashland, Mass.

Circle **540** on inquiry card.

Temperature Control. New set of 2- and 4-page bulletins describe maker's electric temperature control, detection and indicating devices; aircraft gas turbine thermocouples; dynamic detectors; "Series 20000" liquid-filled snap-action "Thermoswitch" units; "Series 511" remote-bulb temperature control; "Series 540 and 560" temperature indicating controllers; and midget "Thermoswitch" controls.—Fenwal, Inc., Ashland, Mass.

Circle **541** on inquiry card.

Temperature Control. New 8-page Data Sheet 5.1-4 describes application of maker's instrumentation for temperature control of various types of plating tanks.—Minneapolis-Honeywell Regulator Co., Phila. 44, Pa.

Circle **542** on inquiry card.

Thermocouple Circuit Checker. New 8-page Catalog R-22 describes maker's "Restorer" device for detecting faults and correcting inaccurate temperature readings in t.c. systems.—Peerless Electric Co., 1401 W. Market St., Warren, Ohio.

Circle **543** on inquiry card.

Thermocouple Potentiometer. New 2-page illustrated Bulletin 270-45 describes maker's "Model 2745" portable precision thermocouple potentiometer readable to ± 0.001 mv.—Rubicon Co., Ridge Ave. at 35th St., Philadelphia 32, Pa.

Circle **544** on inquiry card.

Combustion Control Systems. New 4-page bulletin describes maker's automatic valves, controllers, governors, regulators, for pressure, temperature, process and combustion control.—A. W. Cash Co., P. O. Box 551, Decatur, Ill.

Circle **545** on inquiry card.

Fire Detector. New 8-page Bulletin 31-i-31 describes maker's "Fireye FD-10A and FD-20" infrared-sensitive fire-detection systems.—Electronics Corp. of America, 77 Broadway, Cambridge 42, Mass.

Circle **546** on inquiry card.

Temperature Indicator. New 2-page bulletin describes maker's "Model 33A Temp-Tell" for measuring temperature in bulk grain or other materials in storage.—Tel-Tronics Products, Inc., 125 Keel Ave., Memphis, Tenn.

Circle **547** on inquiry card.

Temperature Controller. New 2-page Bulletin JE-1 describes maker's

HOKE

Flow Sheet

Hoke reports on fluid control

THREE RING PERFORMERS

...the O-ring stem seal is one of the special features that make Hoke valves star performers in the fluid control field. Hoke needle, toggle and metering valves are designed with Hycar® O-rings because of this kind of performance:

...they seal leak-tight (these valves will pass high vacuum tests right off the production line!)...they stay leak-tight, you can forget about periodic packing adjustments...and they offer finger-tip control with no packing friction or binding.

Hoke pioneered the O-ring in small valve applications and you'll benefit from this engineering leadership in using Hoke valves on your test equipment, in the laboratory or for instrument air lines.

May we send you catalog information on these three ring* performers?

*(O-rings, that is)

HOKE

HOKE INCORPORATED

Fluid Control Specialists

233 S. BEAM STREET, ENGLEWOOD, N. J.

For more information circle **185** on inquiry card.

some people told us....

"IT CAN'T BE DONE"

Yes, there were many old-timers who told us we would lose our shirts when we went into the annunciator alarm business two years ago.

They had good reasons . . . "too specialized a field", "deeply entrenched competition" . . . these, and many others.

We listened and went ahead with our plans. Why? Because we were confident that our Scam-designed annunciators had *so much more to offer*—in the way of interchangeability, multiple usefulness and rock-bottom economy through standardization—that industry would "make room" for us.

Happily for us, we were right! Our basic Scam design met with almost immediate acceptance. We are entering our third year with an expanded line of annunciators to meet every requirement—each with basic advantages that are exclusively Scam's.

Scam annunciators are in use today in petroleum, power, chemical, steel and Atomic Energy plants.

Our sales engineering organization is nationwide. There are Scam representatives in Chicago, New York, Philadelphia, Boston, Buffalo, Pittsburgh, Cleveland, Atlanta, Los Angeles, San Francisco, Seattle, Houston, St. Louis, Kansas City, Cincinnati, Detroit and Canada.

They said, "It Can't Be Done", yet we are entering our third year with the largest backlog in our history —and with the stimulating knowledge that there's always room for a new product in a competitive field if it can contribute something new in features and performance.

SCAM INSTRUMENT CORPORATION
CHICAGO 18, ILLINOIS

For more information cicle **186** on inquiry card.

NEW LITERATURE

"Series JE" portable temperature controller.—West Instrument Corp., 525 No. Noble St., Chicago 22, Ill.

Circle **548** on inquiry card.

Thermostat Metal. New 82-page loose-leaf bound illustrated Booklet PR 750 presents description, applications and production of maker's "Truflex" thermostat metal.—Metal & Controls Corp., General Plate Div., Attleboro, Mass.

Circle **549** on inquiry card.

Thermostats. New 6-page bulletin presents specifications of maker's "Models PD-S, PD and KF" miniature hermetically-sealed thermostats.—Chatham Controls Corp., 110 Summit Ave., Chatham, N. J.

Circle **550** on inquiry card.

Pyrometer. New 4-page bulletin describes maker's "Pyruni" radiation pyrometer with ranges from 200 to 7000°F.—Victor George Herman, 311 W. 97 St., New York 25, N. Y.

Circle **551** on inquiry card.

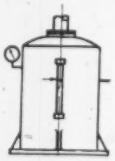
Paper Thermometers. Two new 6-page leaflets describe maker's "Thermopaper" paper thermometers and "Thermotube" sealed-in-glass paper thermometer.—Paper Thermometer Co., 10 Stagg Drive, Natick, Mass.

Circle **552** on inquiry card.

Environmental Testing Facilities. New 4-page brochure describes maker's services and facilities for environmental testing. Includes tables of parameters measured, range and accuracy of measurement.—American Electronic Laboratories, Inc., 641 Arch St., Phila. 6, Pa.

Circle **553** on inquiry card.

PRESSURE, LEVEL



Pressure Instruments, Valves. New 16-page Bulletin G-100 presents maker's extensive line of barometers, manometers, instrument test chambers, turn tables, tachometer testers, needle valves, etc.—Ideal-Aerosmith, Inc., 12909 S. Cerise Ave., Hawthorne, Calif.

Circle **554** on inquiry card.

Pressure Load. New 2- and 4-page Bulletins PG-4 describe maker's mechanical pressure gage for measuring mechanical pressures or compressive loads.—W. C. Dillon & Co., Inc., 14620 Keswick St., Van Nuys, Calif.

Circle **555** on inquiry card.

Rupture Discs. New 2-page Bulletin 552 describes maker's rupture-disc assemblies "Type 552" containing a

Answers to I.Q. Quiz on page 1342

1.—c	5.—b	9.—b
2.—d	6.—d	10.—d
3.—d	7.—a	
4.—d	8.—a	

for **PRECISE CONTROL:**

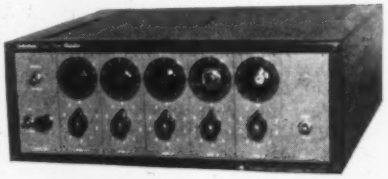
for **AUTOMATIC CONTROL:**

equip your production lines with

ATOMIC'S

fast, rugged, reliable,

PRE-SET COUNTER-CONTROLLERS



features:

- Count items, events or units of process flow up to any pre-selected number
- Visually display the progress of every count
- Provide electrical control of any external function when pre-set count is reached
- Handle continuous or random counts
- Various counting rates available, up to maximum of 20,000 counts per second, according to model
- Available in single or dual pre-set types for control at one or at both of two chosen quantities
- Manual or automatic re-cycling

A wide range of models, both pre-set and totalizing, are available through unique unitized design. Models are described in the new Industrial Count and Control Systems Bulletin – write for your copy.

ATOMIC INSTRUMENT COMPANY
CAMBRIDGE 39, MASSACHUSETTS, U. S. A.

For more information circle **187** on inquiry card.

laminated frangible element set to burst at predetermined pressure.—Henry Valve Co., 3215 North Avenue, Melrose Park, Ill.

Circle **556** on inquiry card.

Tank Gages. New 8-page Bulletin 6004 describes maker's line of remote-reading liquid depth gages.—Liquidepth Indicators, Inc., 43-22 Tenth St., Long Island City 1, N. Y.

Circle **557** on inquiry card.

FLOW

Electronic Flowmeters. New 12-page Booklet 55-1074-222 describes maker's electronic flowmeters for measuring differential pressures, liquid level, temperatures, and pressures. Includes principles and models.—Hays Corp., Michigan City, Ind.

Circle **558** on inquiry card.

Orifice Plates. New 4-page illustrated Bulletin 54-C describes maker's orifice plates. Includes price list.—Industrial Instrument Corp., Odessa, Tex.

Circle **559** on inquiry card.

Purge Meter. New 2-page illustrated Bulletin 135 describes maker's "Sho-Rate 50" purge meter for metering small flow of liquids or gases.—Brooks Rotameter Co., Lansdale, Pa.

Circle **560** on inquiry card.

Differential-pressure Transmitter. New 8-page Bulletin 1102 describes maker's "H/P" differential-pressure transmitter. Using Barton flowmeter and Moore Transmitter.—Moore Products Co., H & Lycoming Sts., Phila. 24, Pa.

Circle **561** on inquiry card.

Liquid Metering. New 16-page leaflet pictures and describes maker's "Smithway PM-2" meter, inventory controller, "Model S" meters, high-pressure meters, "APM-2" meter, etc.—A. O. Smith Corp., 5715 Smithway St., Los Angeles 22, Calif.

Circle **562** on inquiry card.

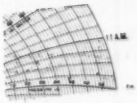
Controlled-volume Pumps. New 4-page Bulletin H20-1 describes maker's "Model H20" controlled-volume pump for accurate chemical feed at low cost.—Milton Roy Co., 1300 E. Mermaid Lane, Philadelphia 18, Pa.

Circle **563** on inquiry card.

Velocity Profile Technique.—New 100-page booklet is WADC Technical Report 54-100 on "Boundary Layer Radioactive Tracer Technique" for measurement of velocity profiles in flowing fluids.—Wright Air Development Center, Air Research and Development Command, United States Air Force, Wright-Patterson AFB, Ohio.

Circle **564** on inquiry card.

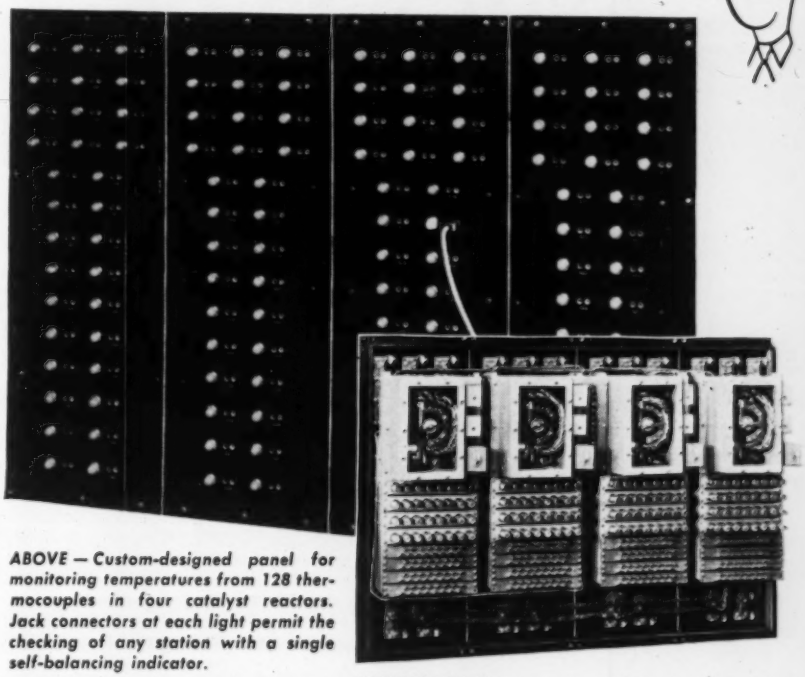
RECORDING



Oscillographs. New 16-page issue of CEC Recordings (Vol. 9, No. 3) features article on "CEC Oscillograph Solves Plane Breakup Mystery." Other articles show uses for mass spectrometers, leak detectors and principles of strain gages.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

Circle **565** on inquiry card.

INTERESTED IN TEMPERATURE MONITORING SYSTEMS?



ABOVE — Custom-designed panel for monitoring temperatures from 128 thermocouples in four catalyst reactors. Jack connectors at each light permit the checking of any station with a single self-balancing indicator.

RIGHT — Rear view of above panel, showing stepping switches, sequencing relays, banks of signal memory relays and thermocouple connection strips.

FUNCTION—Thermo Electric Temperature Monitoring Systems signal dangerous temperatures (or other conditions) at any one of up to several hundred points. Employing resistance bulbs or thermocouples, these systems contain a minimum number of components—guaranteed by a single supplier—Thermo Electric Co.

OPERATION — Each sensing element is connected ot a sequence-stepping switch, controlled by an impulse timer, which steps from contact to contact and transmits the signals to a master measuring unit. A visual-audible warning system for each element positively indicates the existing condition.

TYPICAL APPLICATIONS —

FURNACES
PUMPING STATIONS
POWER PLANTS
MULTI-ZONE OVENS
ATOMIC PILES
WET-TANK PROCESSES
PROCESS LINES
CATALYST BEDS
FOOD & CHEMICAL STORAGES
FLOUR BINS
GRAIN ELEVATORS
SYNTHETIC FIBER-SPINNING POTS
PLASTIC MOLDERS
AIR CONDITIONING SYSTEMS

If you are interested in any of the products shown here, we should be happy to send you descriptive literature.

Thermo Electric News Announcements

DON'T MISS THE ISA SHOW IN LOS ANGELES— SEPTEMBER 12th TO 16th!! WE WILL BE IN BOOTH 404-405, DISPLAYING THESE ITEMS:

TEMPERATURE MONITORING SYSTEMS
TEMPERATURE CONTROLLERS
INDICATING RECORDERS
SELF-BALANCING INDICATORS
MANUAL-BALANCE INDICATORS
RECORDING CONTROLLERS
THERMOCOUPLES
THERMOCOUPLE WIRES
THERMOCOUPLE EXTENSION WIRES
CONNECTOR PANELS
QUICK-COUPLING CONNECTORS
ACCESSORIES
and

"CERAMO"... our latest high temperature, metal-clad, ceramic thermocouple wire

We have openings for qualified sales engineers and design engineers with electro-mechanical or instrument experience. Include résumé with letter of application. Salary commensurate with experience.

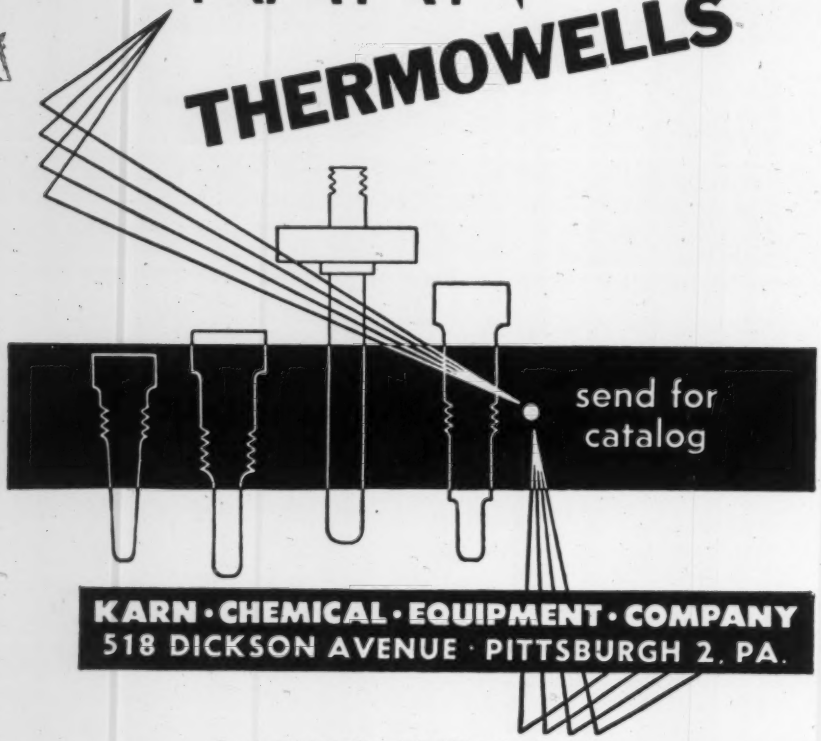
Thermo Electric Co., Inc.

SADDLE RIVER TOWNSHIP, ROCHELLE PARK POST OFFICE, NEW JERSEY
IN CANADA—THERMO ELECTRIC (Canada) Ltd., BRAMPTON, ONTARIO

For more information circle **188** on inquiry card.

KARN

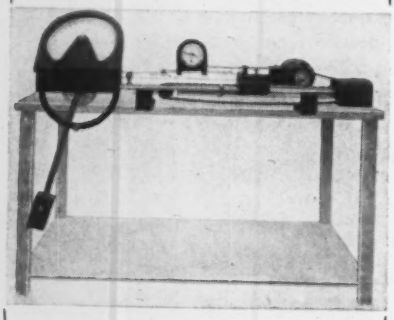
THERMOWELLS



KARN • CHEMICAL • EQUIPMENT • COMPANY
518 DICKSON AVENUE · PITTSBURGH 2, PA.

For more information circle **189** on inquiry card.

AMTHOR
TENSILE STRENGTH
TESTERS



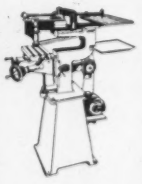
type 274
for VERY LIGHT MATERIALS
Horizontal type—Bench Model
Various ranges up to maximum of 25 lbs.
With or without elongation indicator.

Write for New Catalogue

AMTHOR
TESTING INSTRUMENT CO., INC.
45 Van Sinderen Ave., Brooklyn, N. Y.

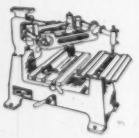
For more information circle **190** on inquiry card.

ENGRAVING
MACHINES
FLOOR
and
BENCH
MODELS



Highly efficient precision machines for engraving steel, other metals and plastics.

You're always safe in buying PREIS-PANTO Engraving Machines and Accessories. Several models available for 2 and 3 Dimensional Engraving.



Write for catalog and prices

TRADE MARK
PANTO

H. P. PREIS Engraving Machine Co.
661 U. S. Highway 22 Hillside, N. J.

For more information circle **191** on inquiry card.

NEW LITERATURE

Oscillographs, Wattmeters, Ammeters. New 8-page issue of "Right Angle" (Vol. 2, No. 4) features article on "Design of Electronic AC Wattmeter and RMS Volt/Ammeter," and describes various uses of maker's recording oscillographs.—Sanborn Co., Industrial Div., Cambridge 39, Mass.

Circle **566** on inquiry card.

Data Displays. New 16-page issue of "Experimenter" (Vol. 29, No. 11) features article on "A New System for Automatic Data Display" comprising sweep drive for display of amplitude-frequency data.—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

Circle **567** on inquiry card.

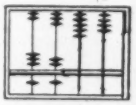
Drafting. New 36-page booklet "Simplified Drafting" pictures and describes methods for simplifying drafting.—American Machine & Foundry Co., 11 Bruce Place, Greenwich, Conn.

Circle **568** on inquiry card.

Emergency Chart Drive. New 4-page Bulletin 100 describes maker's spring-driven "Fail-Safe" chart drive that starts immediately upon power failure.—Duplex Clock Co., Inc., 226 Mill St., Waterbury, Conn.

Circle **569** on inquiry card.

COMPUTERS



Computers, Recorders. New 12-page catalog presents specifications of maker's 6-channel recorder, d-c analog computer, AM-FM electronic multiplier and 6-channel electronic function generator.—Mid-Century Instrumatic Corp., 611 Broadway, New York 12, N. Y.

Circle **570** on inquiry card.

Computer Newsletter. New 6-page "Rea-Letter #1" presents a brief progress report on maker's recent developments in automatic control and data processing fields.—J. B. Rea Co., 1723 Cloverfield Blvd., Santa Monica, Calif.

Circle **571** on inquiry card.

Code Converter. New 4-page illustrated bulletin describes maker's "Trak" code converter for conversion of code signals to printed page copy.—CGS Laboratories, Inc., 391 Ludlow St., Stamford, Conn.

Circle **572** on inquiry card.

Standard Deviation Computer. New 2-page data sheet describes maker's "Model 6055" standard-deviation analog computer for computing integral of the square or mean square of an a-c or d-c input voltage.—Cedar Engineering, Inc., 5806 W. 36th St., Minneapolis 16, Minn.

Circle **573** on inquiry card.

COUNTING

Counters. New 4-page Bulletin 212.7 describes and illustrates "Sodeco" line of 4-digit and 5-digit electro-magnetic impulse counters.—Landis & Gyr, Inc., 45 West 45th St., New York 36, N. Y.

Circle **574** on inquiry card.

Counters. New 12-page booklet illustrates maker's electric pulse-actuated counter with remote electrical indication of totalized pulse inputs.—Nemeth, Inc., 2223 So. Carmelina Ave., Los Angeles 64, Calif.

Circle **575** on inquiry card.

Load Counters. New 2-page Bulletin L-2 describes maker's "Model L" load counter for counting load strokes produced by mechanical presses, shearing and cut-off machines, etc.—Control Devices, Inc., 8299 E. Nine Mile Rd., Van Dyke, Mich.

Circle **576** on inquiry card.

Magnetic Counter. New 2-page bulletins describe maker's "Model MC-504 SZL" magnetic counter; control counters "PC-500 and CC-500" for visual and electrical indication of shaft rotation; and "Lite-Gage LG-402" for controlling lamp exposures.—Photocon Research Products, 421 N. Foothill Blvd., Pasadena 8, Calif.

Circle **577** on inquiry card.

SPEED

Recording Tachometer. New 2-page Bulletin 55 describes maker's "Type 317" indicating and recording tachometer for recording operation of the machine on which it is installed.—Amthor Testing Instrument Co., Inc., 45-53 Van Sinderen Ave., Brooklyn 7, N. Y.

Circle **578** on inquiry card.

Speed Indicator. New 2-page Bulletin 791 describes maker's "Standco" direct reading surface-speed indicator for yards-per-minute indication of moving conveyor belts, etc.—Herman H. Sticht Co., Inc., 27 Park Place, New York 7, N. Y.

Circle **579** on inquiry card.

Control Tachometer. New 2-page descriptive Bulletin 793 illustrates maker's "Model SA-6" alarm contact tachometer for controlling machine speeds and actuating equipment through relays, etc.—Herman H. Sticht Co., Inc., 27 Park Place, New York, N. Y.

Circle **580** on inquiry card.

Tachometers. New 4-page Bulletin describes maker's centrifugal hand tachometers for accurate measurement of rotary and surface speeds.—Boulin Instrument Corp., 65 Madison Ave., New York 16, N. Y.

Circle **581** on inquiry card.

GAGING

Ultrasonic Gage. New 2-page bulletin describes maker's "Echoscope" electronic metal-flaw detector, thickness gage, and fluid level indicator.—Curtiss-Wright Corp., Caldwell, N. J.

Circle **582** on inquiry card.

Beta Gaging. New 2-page bulletin describes and illustrates maker's beta gage for measuring weight-per-unit-area or thickness of sheet or strip without physical contact.—Curtiss-Wright Corp., Electronics Div., Carlstadt, N. J.

Circle **583** on inquiry card.

EAGLE
CYCL-FLEX reset timer

Insures dependable operation and simplified control circuits

Designed with a sealed dial that covers the elapsed time indicator, the Cycl-Flex Timer permits direct mounting to machine panels that are exposed to oil and dust. Timer switches control four load circuits. Interlocking contacts provided without the use of auxiliary relays. Synchronous motor drive insures accurate timing.

The Cycl-Flex is one of the Eagle family of timers designed to fit into every industrial time control need. Eagle sales engineers, located in 30 principal cities, will analyze your timing applications without obligation.

FREE AUTOMATION BOOKLET

MAIL COUPON TODAY!

Eagle Signal Corporation
Industrial Division, Dept. IA-855
Moline, Illinois

Please send Bulletin 120 containing complete data on the Cycl-Flex Reset Timer and free automation booklet, "See What Timing Can Do for You."

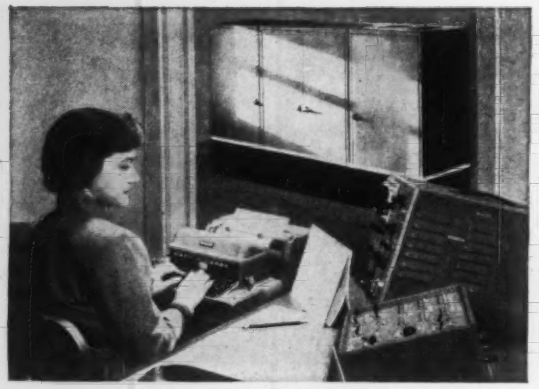
NAME AND TITLE

COMPANY

ADDRESS

CITY ZONE STATE

For more information circle **192** on inquiry card.



alwac III

General Purpose Digital Computer

LOW-PRICED
FULLY AUTOMATIC

THE ALWAC III performs scientific, engineering and business calculations at electronic speed, efficiently and economically. Purchase price of the basic system includes 4096 word magnetic drum digital computer, automatic typewriter, paper tape reader, tape punch and control panel. Alphanumeric punched card converter and magnetic tape storage are also available. Installation, training in programming and maintenance and complete maintenance for 90 days are provided. Equipment may be leased with option to buy.

Write today for the new ALWAC III illustrated brochure.

LOGISTICS RESEARCH INC.
Redondo Beach, Calif.

For more information circle **193** on inquiry card.

"STANDCO"
VIBRATING REED
FREQUENCY METERS

ACCURACY ±.5%

RUGGED—DEPENDABLE

Normal Frequencies:
25, 50, 60 or 400 cycles
Special Ranges:
from 15-1500 cycles

AVAILABLE IN FOLLOWING TYPES:

PANEL MOUNTING: 3½" flush bakelite, metal or hermetically sealed cases Meet all MIL specs.

SWITCHBOARD MOUNTING: 7¼" round surface, or 4½" square semi-flush cases

PORTABLES: In large or small cases

Write for Bulletin 805

HERMAN H. STICHT CO., INC.
27 PARK PLACE NEW YORK, N. Y.

For more information circle **194** on inquiry card.

ROYSON IDENTICHART

Prints identifying number or time and date on chart from remote contact. Write for free descriptive literature.

Designers & Builders of Special Instruments & Electro-Mechanical Devices

Segmental Recorders

Multi-Channel Recorders

Special X-Y Recorders

Modifications to Standard Equipment

ROYSON ENGINEERING
99 N. PENN STREET
Hatboro, Pennsylvania

For more information circle **195** on inquiry card.

NEW LITERATURE

Gage Blocks. New 8-page illustrated catalog presents specifications and prices of maker's line of chromium-plated gage blocks.—Ellstrom Standards Div., Dearborn Gage Co., 22038 Beech St., Dearborn, Mich.

Circle **584** on inquiry card.

Plug Gages. New 4-page folder describes and illustrates maker's line of "Taperlock, Trilock" and wire type cylindrical plug gages and thread plug gages.—Sossner Tap & Tool Corp., Lynbrook, N. Y.

Circle **585** on inquiry card.

Snap Gages. New 12-page Brochure 585 describes and illustrates maker's roll thread snap gages for checking threads.—Pratt & Whitney Div., W. Hartford 1, Conn.

Circle **586** on inquiry card.

Gage Inspection Facility. New 16-page booklet describes Size Control Co.'s new affiliate—The Midwest Gage Laboratory.—Size Control Co., 2500 W. Washington Blvd., Chicago 12, Ill.

Circle **587** on inquiry card.

RADIOACTIVITY

Scintillators. New 20-page booklet is "64 Questions and Answers on Geiger Counters and Scintillators."—Precision Radiation Instruments, Inc., 4223 W. Jefferson Blvd., Los Angeles 16, Calif.

Circle **588** on inquiry card.

Nuclear Radiation Consultants. New 4-page bulletin "Improved Manufacturing and Processing Through Nuclear Radiation" describes engineering and consultation services in nuclear field.—Radioactive Products, Inc., 2421 Wolcott, Ferndale 20, Mich.

Circle **589** on inquiry card.

Scintillation Counters. New 8-page bulletin describes and illustrates maker's portable geiger counters and scintillation counters for uranium prospecting.—Nuclear Measurements Corp., 2460 N. Arlington Ave., Indianapolis 18, Ind.

Circle **590** on inquiry card.

Scintillation Counter. New 2-page illustrated bulletin describes maker's "Percentometer" portable scintillation counter for locating uranium and for radioassays.—Radiac Co., Inc., 489 Fifth Ave., New York 17, N. Y.

Circle **591** on inquiry card.

OPTICAL

Phototubes. New 58-page catalog describes theory, principles, circuits and types of maker's multiplier phototubes and discusses performance in various applications. Price: $1.00.—Allen B. Du Mont Labs., Inc., 760 Bloomfield Ave., Clifton, N. J.

Circle **592** on inquiry card.

Micro Manipulator. New 10-page bulletin describes and illustrates maker's micro manipulator for use in biology, medicine, metal research, etc.—E. Leitz, Inc., 468 Fourth Ave., New York 16, N. Y.

Circle **593** on inquiry card.

Color-dot Alignment. New 2-page bulletin pictures and describes maker's color TV "Tubescope" for alignment of color dot pattern.—Edmund Scientific Corp., Barrington, N. J.

Circle **594** on inquiry card.

Photographic Equipment. New 10-page leaflet describes maker's "Model 4000 Rapromatic" for producing, processing and projecting (all in one portable unit) high-definition pictures.—Kenyon Instrument Co., 1345 New York Ave., Huntington Station, L. I., N. Y.

Circle **595** on inquiry card.

Ultraviolet Light. New 4-page folder describes and illustrates maker's "Model LR" ultraviolet source unit and basic uses in paper and cellulose industry, medicine, leather and tanning, drugs and food products, etc.—Sela Electronics Co., 128 W. 48th St., New York City, N. Y.

Circle **596** on inquiry card.

pH

pH Indicators. New 4-page Data Sheet E-96(2) describes maker's a-c operated pH indicator for pH and redox work.—Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.

Circle **597** on inquiry card.

pH Meter. New 4-page Bulletin 911 describes maker's "Research Model" pH meter for pH and millivolt measurements.—Cambridge Instrument Co., Inc., 3732 Grand Central Terminal, New York, N. Y.

Circle **598** on inquiry card.

pH Adapter. New 2-page Bulletin 120 describes maker's "Swing-Arm" adapter for maker's pH meters for measuring small liquid volumes with fragile electrode tips in tiny beakers.—Photovolt Corp., 95 Madison Ave., New York 16, N. Y.

Circle **599** on inquiry card.

ANALYTICAL

Rheology. New 16-page booklet is article on "Rheology in Paper Coating".—Hagan Corp., Pittsburgh 30, Pa.

Circle **600** on inquiry card.

Viscometer. New 12-page bulletin describes and illustrates maker's cone and plate rotational viscometer used for viscosity measurements in process control.—Ferranti Electric, Inc., 30 Rockefeller Plaza, New York 20, N. Y.

Circle **601** on inquiry card.

Spectrophotometer. New 4-page Bulletin 410 describes maker's "Model IR-2A" automatic infrared spectrophotometer.—Beckman Div., Beckman Instruments, Inc., Fullerton, Calif.

Circle **602** on inquiry card.

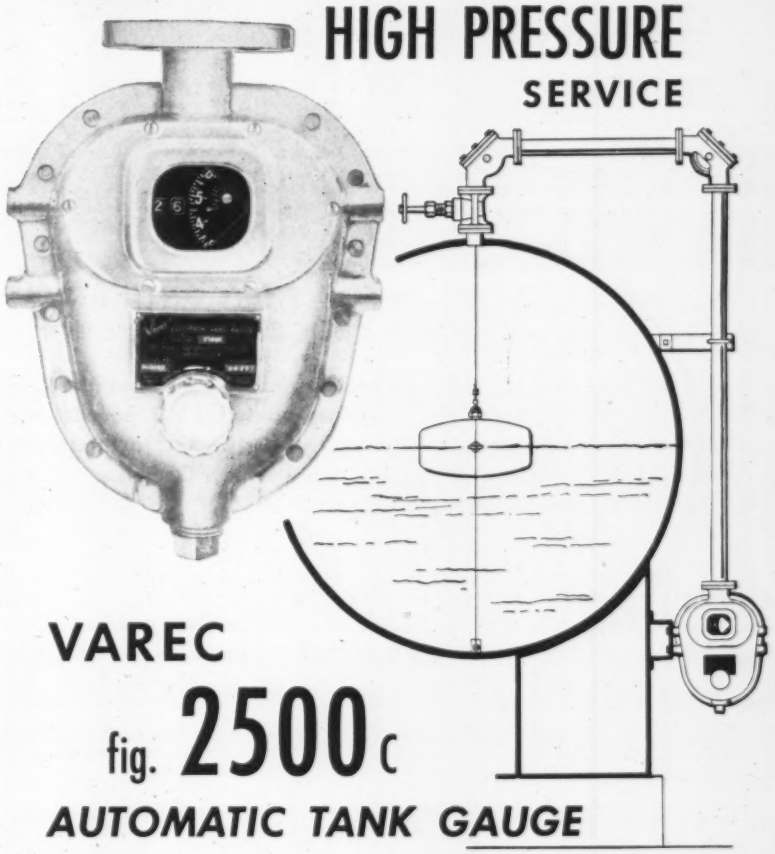
Tin-content Indicators. New 2-page Bulletin F5609-3 describes maker's portable tin-content indicators for determining ratio of lead and tin in solder.—Barber-Colman Co., Wheelco Instruments Div., Rockford, Ill.

Circle **603** on inquiry card.

Purge Meter. New 2-page Bulletin 135 describes maker's Sho-Rate "50" purge meter for metering small flows of gases or liquids.—Brooks Rotameter Co., Lansdale, Pa.

Circle **604** on inquiry card.

NOW- Available for HIGH PRESSURE SERVICE



VAREC

fig. 2500C

AUTOMATIC TANK GAUGE

Service in working pressures to 300 p.s.i.g. is offered by the new VAREC Figure 2500C Automatic Tank Gauge. It's a high pressure model of the successful VAREC Figure 2500 Series, equipped with the Neg'ator motor, which eliminates use of counterweight and simplifies installation. This series has been tested by 3 years of service in the Petroleum and Chemical fields, after 2 years of experimental and development work.

An important part of this new model is the magnetic drive, which requires no packing gland or mechanical seal on rotating shaft. The use of stainless steel ball bearing construction throughout provides a combination that reduces friction to a minimum.

Liquid level indication on a mechanical counter and dial for convenient, easy reading. Components are enclosed in a separate compartment to keep tank vapors from fogging dial. Operation checker is standard equipment.

Like the low pressure series Figure 2500 gauges, addition of remote gauger transmitter or control devices is a simple field installation. It is not necessary to remove the gauge head or disturb the original installation in any way.

"Varec"

VAPOR RECOVERY SYSTEMS COMPANY
2820 North Alameda Street
Compton 1, California

961-9

Cable address: VAREC COMPTON Calif. (U.S.A.) All Codes

For more information circle **196** on inquiry card.

Weighing Systems

by Pneumatic Force Balance

PROVIDE AUTOMATION FOR THE CONTINUOUS OR BATCH PROCESS.

A complete line of weight transmitters in single and multiple diaphragm construction with load capacities up to 23,000 pounds per diaphragm. Pneumatic tare balance for any portion of the total load on all models. All moving parts are enclosed totally. Complete weighing systems designed to your requirements.

WRITE FOR CATALOG

JOHN R. MONSELL COMPANY
Glassboro, N. J.

For more information circle **197** on inquiry card.

MEGOHMER
INSULATION TESTERS

GENERATOR TYPES

MINOR—Dwarf Size
500V, 50 Megohms

MAJOR—Small Size
Constant Voltage 500V
Megohm & Ohm Scales

STANDARD—Heavy Duty
500/1000V
up to 2000 Megs.

BATTERY VIBRATOR TYPES

NON-CRANKING

MODEL B-6—0-200 Megs.
2000 Ohms, AC-DC Volts

MODEL B-7—20/200 Megs.
200/20,000 Ohms.

PLUG IN TYPE

MODEL P-1 for
PRODUCTION TESTING
115V AC line operated
500/1000V
100/1000/2000 Megohms

ELECTRONIC TYPE

20,000,000 Megohms

MODEL 29A with 11 ranges
Range 300,000 to
20,000,000 megohms
Test Potentials
85V/500V

HERMAN H. STICHT CO., INC.
27 PARK PLACE, NEW YORK 7, N. Y.

For more information circle **198** on inquiry card.

Molded
BLACK NYLON SCREWS and NUTS

Insulate and fasten without bushings, washers, etc.
In stock 6-32, 8-32, 10-32

NyGrip **BLACK NYLON Cable Clips**

Light-weight non-conducting support for wiring, tubing, etc.
In stock 1/16" to 1 1/2" dia.

Free Samples...Write
WECKESSER CO.
5258 N. Avondale Avenue • Chicago 30, Illinois

For more information circle **199** on inquiry card.

LABORATORY

Lab Circulator. New 4-page brochure includes description, diagram, and price data on maker's constant-temperature circulator.—Bronwill Scientific, Inc., P. O. Box 127, 131 Gould St., Rochester 10, N. Y.

Circle **605** on inquiry card.

Precision Stirrers. New 8-page Bulletin PS-1 describes maker's modified precision stirrer assemblies.—Kontes Glass Co., Vineland, N. J.

Circle **606** on inquiry card.

Surface Tension Tester. New Bulletin 2 describes maker's "Jiffy Loop" surface tension tester for measurement of surface tensions of solutions up to 200° F.—Pollack Products Co., 1628 E. 7th St., Brooklyn 30, N. Y.

Circle **607** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

Electrical Standard Instruments. New 8-page Catalog A464 describes maker's laboratory standard instruments including voltmeters, ammeters, wattmeters, etc.—Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

Circle **608** on inquiry card.

R-F Bridge. New 12-page issue of "Experimenter" (Vol. 30, No. 1) describes maker's "Type 916-A" radio-frequency bridge for measurements on antennas, lines, networks and components.—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

Circle **609** on inquiry card.

Detonator-safe Initiators. New 2-page Data Sheet DSI-555 describes maker's "Model 173-1" lanyard-armed electrically-fired initiators; and "Model 175-1" electrically-armed, electrically-fired, telemetered, detonator-safe initiators.—Beckman & Whitley, Inc., 985 San Carlos Ave., San Carlos, Calif.

Circle **610** on inquiry card.

Signal Converter. New 4-page engineering bulletin describes maker's "Model MH-01 Micromag" d-c signal converter for converting low-level d-c signals into a-c signals by second-harmonic saturable-reactor technique.—Magnetic Research Corp., 200-202 Center St., El Segundo, Calif.

Circle **611** on inquiry card.

Magnetic Signal Amplifier. New 4-page Engineering Bulletin EB-201-A describes and illustrates maker's "Micromag" low-level magnetic signal amplifier for thermocouple and strain-gage applications.—Magnetic Research Corp., 200-202 Center St., El Segundo, Calif.

Circle **612** on inquiry card.

Electronic Instruments, Components. New 16-page issue of "This Month" pictures and describes distributor's actuators, analyzers, blowers, calibrators, dynamotors, gages, magnets, meters, motors, recorders, relays, switches, thermometers, etc.—Herbach & Rademan, Inc., 1204 Arch St., Philadelphia 7, Pa.

Circle **613** on inquiry card.

Square-wave Generator. New 4-page issue of "H-P Journal" (Vol. 6, No. 9) features article on new 1-cps to 1 Mc square-wave generator with a 20-millimicrosecond rise time.—Hewlett-Packard Co., 275 Page Mill Rd., Palo Alto, Calif.

Circle **614** on inquiry card.

Capacitance Measurement. New 2-page Data Sheet 901-1 presents specifications on maker's "Delta" unit for measurement of capacitance variation, using "T-42" ionization transducer.—Decker Aviation Corp., 1361 Frankford Ave., Philadelphia, Pa.

Circle **615** on inquiry card.

Aircraft Testing Equipment. New 24-page Bulletin pictures and describes maker's aircraft electrical test equipment including a-c generator and controls test stand, reactor load bank, flasher coder and tester, etc.—United Mfg. Co., Div. W. L. Maxson Corp., 41 Haig St., Hamden 14, Conn.

Circle **616** on inquiry card.

Panel Instruments. New 2-page Bulletin P4C-1 pictures and describes maker's 4½" panel instruments with illuminated scales.—Phaostron Co., 151 Pasadena Ave., S. Pasadena, Calif.

Circle **617** on inquiry card.

Dynamometer Volt-ammeter. New 4-page issue of "Electrical Measurements" (Vol. 22, No. 3) describes maker's a-c laboratory standard dynamometer volt-ammeter for use at 50 to 500 cycles.—Sensitive Research Instrument Corp., Mount Vernon, N. Y.

Circle **618** on inquiry card.

Signal Generator. New 4-page issue of "Hewlett-Packard Journal" (Vol. 6, No. 10) features article on "New 15-21-KMC 10-MW Signal Generator."—Hewlett-Packard Co., 275 Page Mill Rd., Palo Alto, Calif.

Circle **619** on inquiry card.

Testing Equipment. New 4-page Bulletin 555 describes maker's "Multi-Amp" portable high-current test instruments for testing and calibrating.—Multi-Amp Corp., 10 Third St., Newark 7, N. J.

Circle **620** on inquiry card.

Switching Circuits. New 20-page issue of "Capacitor" (Vol. 20, No. 7) describes trigger and switching circuits.—Cornell-Dubilier Electric Corp., Hamilton Blvd., So. Plainfield, N. J.

Circle **621** on inquiry card.

Semiconductor Test Sets. New 2-page Bulletin TP-103 outlines characteristics of maker's semiconductor minority carrier test set. 2-page Bulletin TP-104 discusses semiconductor resistivity test set for range of 0.1 to 100 ohm-centimeters.—Baird Associates, Inc., 33 University Rd., Cambridge 38, Mass.

Circle **622** on inquiry card.

Oscilloscopes. New 2-page Bulletin CC-705 describes and illustrates maker's "VS-900B" oscilloscopes.—Volkers & Schaffer Mfg. Corp., Box 996, Schenectady, N. Y.

Circle **623** on inquiry card.

Oscilloscope Preamp. New 2-page Bulletin CC-706 describes maker's "VS-61A" ultra-sensitive low-noise os-

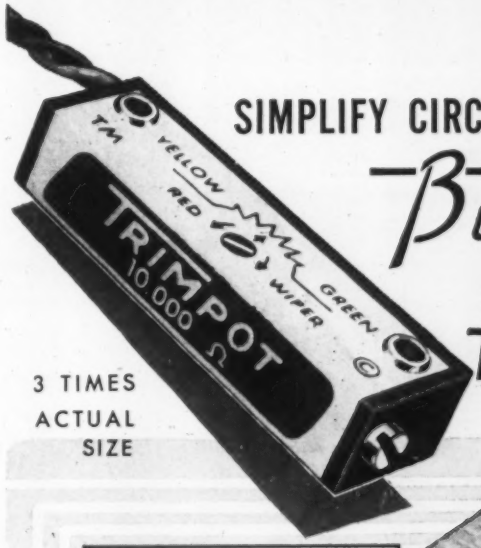
SIMPLIFY CIRCUIT TRIMMING *with*

BOURNS

sub-miniature

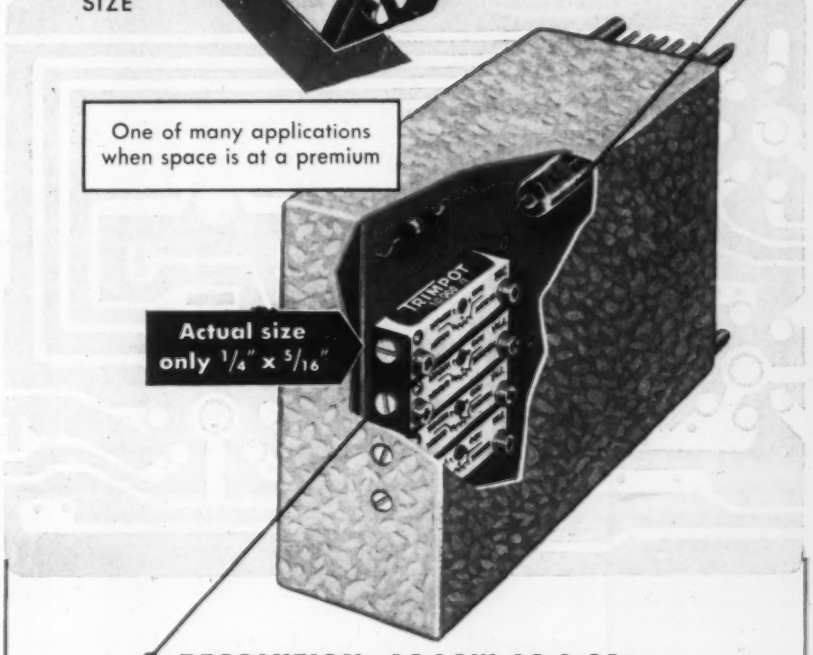
TRIMPOTS®

TRADE MARK



3 TIMES ACTUAL SIZE

One of many applications when space is at a premium



Actual size only ¼" x 5/16"

- **RESOLUTION: AS LOW AS 0.25%**
- **POWER RATING: 0.25 WATT AT 100° F.**
- **WEIGHT: ONLY 0.1 OZ.**

BOURNS ***TRIMPOT*** is a 25 turn, fully adjustable wire-wound potentiometer, designed and manufactured exclusively by BOURNS LABORATORIES. This rugged, precision instrument, developed expressly for trimming or balancing electrical circuits in miniaturized equipment, is accepted as a standard component by aircraft and missile manufacturers and major industrial organizations.

Accurate electrical adjustments are easily made by turning the exposed slotted shaft with a screw driver. Self-locking feature of the shaft eliminates awkward lock-nuts. Electrical settings are securely maintained during vibration of 20 G's up to 2,000 cps or sustained acceleration of 100 G's. BOURNS ***TRIMPOTS*** may be mounted individually or in stacked assemblies with two standard screws through the body eyelets. Immediate delivery is available in standard resistance values from 10 ohms to 20,000 ohms. BOURNS ***TRIMPOTS*** can also be furnished with various modifications including dual outputs, special resistances and extended shafts.

BOURNS *also manufactures precision potentiometers to measure Linear Motion; Gage, Absolute, and Differential Pressure and Acceleration*

BOURNS LABORATORIES

6135 MAGNOLIA AVENUE, RIVERSIDE, CALIFORNIA

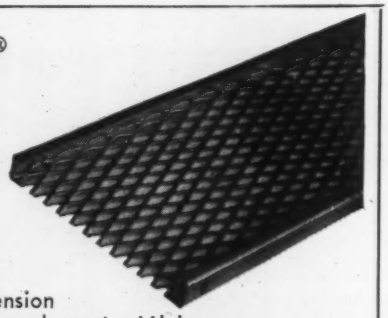
© B. L. PATENTS PENDING

Technical Bulletin On Request, Dept. 22

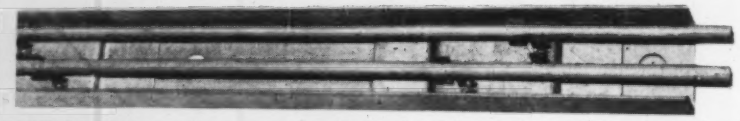
For more information circle **200** on inquiry card.

TUBETROF®

for Supporting Instrument Tubing



- P-W Manufactures a complete trough system with positive Connectors — Tube Clips — Cushion Clamps—I Section for long Spans (No bolting of lattice bars)—Extension Connector eliminates all cutting—Trough up to 16' Long.



- Tube-Raceway to support a limited number of tubes that branch off from main Tubetrof.

Twist-Rack®

The Structure To Support Tubetrof

. . . Cabletrof . . . Shelving . . . Conduit . . . Cables . . . Pipe, Etc.

Write today for Bulletins

P-W INDUSTRIES, INC.,

Duncan & Melrose Sts., Phila. 24, Pa.

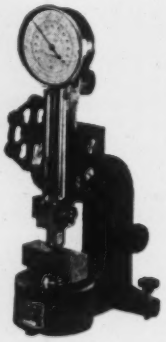
You are cordially invited to visit our booth, D-607, at the ISA show in Los Angeles.

For more information circle **201** on inquiry card.

HARDNESS TESTING...

done WITH NO MENTAL HAZARDS. The SCLEROSCOPE has done it for the past 50 years.

In general use for specification purposes. Simple, sturdy Comparatively inexpensive.



Illustrated bulletins free

The Shore Instrument & Mfg. Co., Inc.

90-35 Van Wyck Expressway Jamaica 35, N. Y.

For more information circle **202** on inquiry card.

Over 85% of the torque wrenches used in industry are

Sturtevant

TORQUE WRENCHES

Read by Sight, Sound or Feel.

- Permanently Accurate
- Practically Indestructible
- Faster—Easier to use
- Automatic Release
- All Capacities

in inch grams...inch ounces,..inch pounds ...foot pounds (All sizes from 0-6000 ft. lbs.)

Every manufacturer, design and production man should have this valuable data. Sent upon request.

PA STURTEVANT CO

For more information circle **203** on inquiry card.

cilloscope pre-amplifiier.—Volkers & Schaffer Mfg. Corp., Box 996, Schenectady, N. Y.

Circle **624** on inquiry card.

Panel Instrument. New 2-page Bulletin R131-455 describes maker's "Model 131" 1½ inch panel instrument for size and weight reduction in electronic equipment subject to shock, vibration or temperature extremes.—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle **625** on inquiry card.

Regulators. New 8-page Bulletin 6.04 describes maker's "Regohm" regulators for regulating voltage by direct control of main fields of large alternators and generators.—Electric Regulator Corp., Norwalk, Conn.

Circle **626** on inquiry card.

Temperature-compensated Regulator. New 2-page Bulletin 5.02 describes maker's Regohm finger-type regulator with temperature compensation.—Electric Regulator Corp., 502 Pearl St., Norwalk, Conn.

Circle **627** on inquiry card.

Oscilloscopes. New 4-page brochure describes and illustrates maker's new line of portable and panel-mount oscilloscopes, and waveform monitors.—Probescope Co., 44-05 30th Ave., Long Island City 3, N. Y.

Circle **628** on inquiry card.

Resistance Comparator. New 2-page Bulletin 12-54 describes maker's resistance comparator for measuring or comparing resistances.—R. L. Fearn, 375 S. Main St., Homer City, Pa.

Circle **629** on inquiry card.

Volt-ammeter. New 6-page bulletin describes foreign-made "Universal Meter UM" with frequency range of 15 cps to 20 kc.—Donald C. Seibert, Foot of Christiana Ave., Wilmington, Del.

Circle **630** on inquiry card.

Oscilloscopes. New 16-page Booklet 455 describes maker's "Type 530-Series" oscilloscopes; "Type 53" plug-in units; and "Type 53/54" plug-in-units.—Tektronix, Inc., P. O. Box 831, Portland 7, Oreg.

Circle **631** on inquiry card.

POTENTIOMETERS

Potentiometer Resolution. New 8-page descriptive bulletin "Resolution in Precision Wire Wound Potentiometers" defines various types of potentiometer resolution for which some standardization has been accomplished.—Fairchild Camera and Instrument Corp., Park Ave., Hicksville, L. I., N. Y.

Circle **632** on inquiry card.

Potentiometers. New 2-page Data Sheet 54-11 pictures and describes maker's series AN and CN multi-turn precision potentiometers for servo mounting.—Helipot Corp., 916 Meridian Ave., S. Pasadena, Calif.

Circle **633** on inquiry card.

Potentiometer. New 2-page "Model K-200" Bulletin K200-455 presents technical data on maker's high-reso-

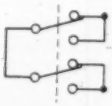
lution potentiometer for low-torque, high-function-angle applications.—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle **634** on inquiry card.

Potentiometers. New 4-page bulletin presents specifications on maker's "Series BC-200" 2-inch ball-bearing potentiometers.—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle **635** on inquiry card.

RELAYS, SWITCHES



Relays. New 6-page Bulletin RH-7 describes maker's "Series PTW" polar relay used in teletypewriter repeater circuits and polarized relay applications.—Automatic Electric Sales Corp., 1033 W. Van Buren St., Chicago 7, Ill.

Circle **636** on inquiry card.

Stepping Switch. New 2-page Bulletin RH 6 describes types of rotary stepping switches used in data reduction.—Automatic Electric Sales Corp., 1033 W. Van Buren St., Chicago 7, Ill.

Circle **637** on inquiry card.

Switches. New 4-page issue of "Micro Tips" (Vol. 1, No. 17) describes method of installing a snap-action switch on a 200-ton transfer molding press, and other switch applications for safety protection of men and machines.—Micro Switch Division, Freeport, Ill.

Circle **638** on inquiry card.

Relay Assemblies. New 148-page "Final Test Report No. 2029" reports on tests and results on counter-poise relay assemblies and switches. Includes tests for shock, moisture, sealing, temperature, etc.—Inland Testing Laboratories, 1457 Diversey Parkway, Chicago 14, Ill.

Circle **639** on inquiry card.

Relays. New 2-page Bulletin 7138 describes maker's "Model M-100" subminiature relay.—Luther Manufacturing Co., 7312 Varna Ave., N. Hollywood, Calif.

Circle **640** on inquiry card.

Relays, Components. New 12-page catalog presents distributor's line of hermetically sealed relays, timing motors, a-c relays, aircraft solenoid contactors, rectifiers, capacitors, etc.—Universal General Corp., 324 Canal St., N. Y. C. 13, N. Y.

Circle **641** on inquiry card.

Switches. New 10-page Bulletin 263 describes maker's "Tyni" snap-acting switch for control and indicating circuits.—Detroit Controls Corp., 5900 Trumbull Ave., Detroit 8, Mich.

Circle **642** on inquiry card.

Switches. New 2-page Bulletins 100 and 105 describe maker's "Series 5700 and 5900" interlocking push-button switches.—Donald P. Mossman, Inc., Brewster, N. Y.

Circle **643** on inquiry card.

CONNECTORS

Terminals. New 4-page Catalog 400 describes maker's "Vac-Tite" compression single terminal feed-thru's

ALINA

KNURL CUTTERS

ALINA KNURL CUTTERS actually mill the pattern and produce chips in the process. Alina Knurl Cutters will cut your machining time approx. 30%. They will provide the solution to some of your most complex knurling problems.

DESIGNED TO

- knurl all machineable materials
- knurl thin-walled parts without internal support
- maintain fine diametral limits
- knurl diameters from 1/16" to 10 ft.

Models available for all types of machines.
For detailed information and prices, write to

ALINA CORPORATION • 401 Broadway, New York 13, N. Y.

For more information circle **204** on inquiry card.

AN INSTRUMENT FOR ALL YOUR MAGNETIC MEASURING PROBLEMS

Dyna-Labs

D-79 GAUSSMETER

This precision built instrument measures flux density, determines direction of flow. It locates and measures stray fields and plots variations in strength and checks production lots against a standard. Simple to operate. No ballistic readings . . . no jerking or pulling. Supplied with protective carrying case.

- Other Features -
- Reads 10 to 30,000 Gauss Flux Fields
- Probe is only .025" thick
- Active area .01 square inches
- Overall size 13" x 6-3/4" x 10-1/2"
- Net weight only 10-1/2 lbs
- Power supply 105-125 volts, 50-60 cycles

We invite inquiries. For literature write Department IA-855.

Dyna-Labs INC.

1075 STEWART AVENUE, GARDEN CITY, L. I., N. Y. PIONEER 1-2700

For more information circle **205** on inquiry card.

STEREO— MICROSCOPE

CARL ZEISS

With novel rapid change of magnification from 6x to 160x with wide-angle oculars.

Large working distance from 3¾-in., with diameter of object field up to 32mm. Beyond 80x magnification, the working distance is 1⅝-inch.

Uniform sharpness over the entire field of view. Erect, non-reversed image. Outstanding plasticity; easy on the eyes even during prolonged observation.

Write for Literature

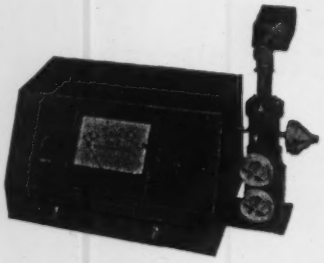
CARL ZEISS, INC.
485 Fifth Avenue
New York 17, N.Y.

Guaranteed Uninterrupted Repair Service

MADE IN WEST GERMANY

For more information circle **206** on inquiry card.

AIR POLLUTION PHOTOMETER



The new *Sinclair-Phoenix Aerosol and Smoke Photometer* employs the forward scattering principle which offers the most practical, intelligent method of accurate air pollution studies, measurements and control.

TYPICAL APPLICATIONS

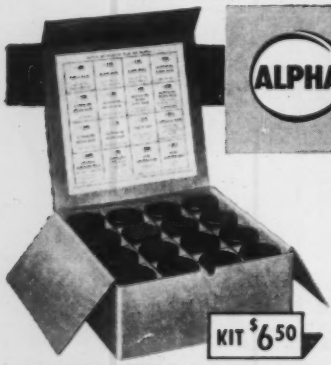
- For air pollution studies of industrial areas, apartment buildings, factory interiors, mines, ship holds, etc.
- As a control and research tool for evaluations of filter designs and devices, air wash and air conditioning systems, gaseous purity studies, etc.

INDICATING—RECORDING—PORTABLE

Phoenix Precision Instrument Co.

3803-05 N. Fifth St., Philadelphia 40, Pa.

For more information circle **207** on inquiry card.



ALPHA

general purpose **SOFT SOLDER**

FLUX KIT

IT IS A TIMESAVER FOR DESIGNERS, ENGINEERS AND PRODUCTION MEN

IN SOLVING FLUXING PROBLEMS

A FLUX for each of your soft soldering operations. This Flux Kit contains a complete assortment of the most useful Fluxes for ELECTRONIC ASSEMBLIES, PRINTED CIRCUITS, TINNING and HOT SOLDER DIPPING, STAINLESS STEEL SOLDERING and ALUMINUM SOLDERING. It enables a rapid determination of the proper Flux for a soldering job. The Flux Kit is the result of thousands of customers' service problems submitted to Alpha's Research Laboratory. Special Fluxes can be compounded to suit individual needs at Alpha's modern Research Laboratory.

ALPHA METALS, INC.
53 Water St., Jersey City, N. J.

For more information circle **208** on inquiry card.

and stand-offs in various diameters.—Hermetic Seal Products Co., 29-37 South Sixth St., Newark 7, N. J.

Circle **644** on inquiry card.

Capacitor-type Connectors. New 8-page issue of "Engineering News" (Vol. 8, No. 3) describes maker's "Series 173" capacitor-type connectors for filtering noises, wherein all pins have minimum capacitance to ground of 2000 uufd.—American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill.

Circle **645** on inquiry card.

Electrical Clips. New 8-page Catalog 180 presents maker's complete line of electrical clips including new miniaturized and special insulated clips.—Mueller Electric Co., 1583 E. 31st St., Cleveland 14, Ohio.

Circle **646** on inquiry card.

Electrical Contacts. New 4-page bulletin describes maker's contacts, rivets, and magnetic-force electrical contact spotwelding method.—Diringer Metallurgical Corp., 8131 Monticello Ave., Skokie, Ill.

Circle **647** on inquiry card.

Connectors. New 4-page Bulletin PN-1 describes maker's AN connectors, including installation instructions.—Deutsch Co., 7000 Avalon Blvd., Los Angeles, Calif.

Circle **648** on inquiry card.

Disconnect Coupling. New 2-page Bulletin PD-1 describes maker's electrical quick-disconnect coupling used in electronics, instruments, etc.—Deutsch Co., 7000 Avalon Blvd., Los Angeles 3, Calif.

Circle **649** on inquiry card.

ELECTRONIC COMPONENTS

Silicon Junction Diodes. New 8-page Bulletin SP-4 describes maker's silicon junction diodes with ambient operating range of from −80 to +200 C.—Hughes Aircraft Co., Culver City, Calif.

Circle **650** on inquiry card.

Pulse Transformers. New 4-page Bulletin PT 301 describes maker's miniature pulse transformers used in triggering, counting, blocking oscillators, pulse shaping, etc.—Acme Electric Corp., Cuba, N. Y.

Circle **651** on inquiry card.

Pulse Transformers. New 2-page Brochure T-36B presents specifications on maker's 'Types PT-1, PT-2, PT-3" pulse transformers used in isolation, impedance matching, blocking oscillators, etc.—Berkshire Laboratories, Greenville, N. H.

Circle **652** on inquiry card.

Pulse Transformers. New 6-page Bulletin PT 301 describes maker's miniature pulse transformers used in triggering, counting, blocking oscillators, etc.—Acme Electric Corp., 1375 W. Jefferson Blvd., Los Angeles, Calif.

Circle **653** on inquiry card.

Tubular Capacitors. New 2-page Bulletin 162 describes maker's "Type BC" phenolic-cased paper tubular capacitors for printed circuits.—Cornell-Dubilier Electric Corp., S. Plainfield, N. J.

Circle **654** on inquiry card.

Electronic Components. New 16-page illustrated Brochure 57 presents description of maker's line of TV and radio products, knobs, switches and other components.—Gee-Lar Mfg. Co., 819 Elm St., Rockford, Ill.

Circle **655** on inquiry card.

MECHANICAL COMPONENTS

Neg'ator Springs. New 16-page Technical Bulletin 310N describes maker's "Neg'ator" spring for loading, counterbalancing, driving, holding, etc.—Hunter Spring Co., Lansdale, Pa.

Circle **656** on inquiry card.

Rotary Latches. New 6-page Brochure C-403 describes and illustrates maker's "Paneloc" rotary latches used on inspection doors, access panels, control panels, etc.—Scovill Manufacturing Co., Waterbury 20, Conn.

Circle **657** on inquiry card.

Gear Train. New 2-page Catalog Sheet 1060 illustrates and describes maker's power motor-gear-train used as a precision speed reducer with low backlash and low composite error.—John Oster Mfg. Co., Avionic Div., 1 Main St., Racine, Wis.

Circle **658** on inquiry card.

Bearings. New 2-page Data Sheet CB-100 describes maker's commercial stud-type bearings.—Grant Pulley & Hardware Corp., 31-85 Whitestone Parkway, Flushing 54, N. Y.

Circle **659** on inquiry card.

Electronic, Electromechanical Devices. New 28-page booklet describes maker's facilities for development and production of electronic and electromechanical products.—Munston Mfg. & Service, Inc., Beech St., Islip, N. Y.

Circle **660** on inquiry card.

Vibration Controls. New 28-page Booklet 900 describes maker's new concepts in vibration and shock control for airborne electronic equipment.—Robinson Aviation, Inc., Teterboro, N. J.

Circle **661** on inquiry card.

Vibration Controls. New 6-page Bulletin 700 describes maker's "Temproof" mountings which provide vibration isolation for stationary industrial equipment.—Lord Mfg. Co., Erie, Pa.

Circle **662** on inquiry card.

Vibration Isolator. New 2-page Data Sheet 5M455-SU describes maker's miniature "All-Angl" shock and vibration isolator used in jets and guided missiles.—Barry Controls, Inc., 700 Pleasant St., Watertown, Mass.

Circle **663** on inquiry card.

Shielded Enclosures. New 12-page booklet describes and illustrates maker's shielded enclosures.—Ace Engineering & Machine Co., 3644 N. Lawrence St., Philadelphia 40, Pa.

Circle **664** on inquiry card.

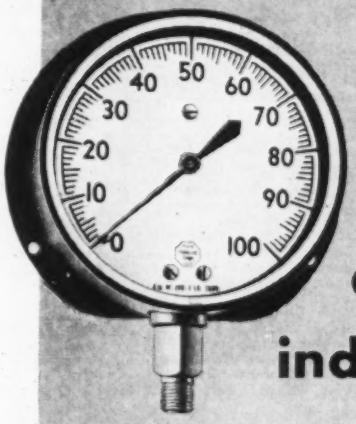
DRYERS, FILTERS

Dryers. New 4-page Bulletin D-101 describes maker's "Oriad" dryer for drying air or gases used to actuate tools, valves, instruments, etc.—C. M.

(*continued on page* 1372)

an ACCO product

Helicoid Gages

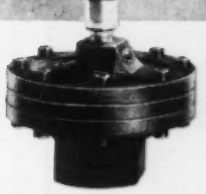


Why HELICOID is the Quality Gage for every pressure indicating service

Acaloy Case Helicoid Gage
Suitable for tap water, steam, inert gases, oils, coal gas and many chemicals.

Built RIGHT

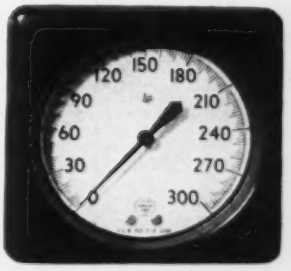
Exclusive HELICOID gearless movement. Bourdon tubes of maximum endurance life. Gives highest degree of *sustained accuracy.*



Helicoid Chemical Gage
Suitable for chemicals and other viscous liquids which might corrode or clog Bourdon tube.

Stay RIGHT

No gear teeth to wear out. Convenient external pointer adjustment. Protected from sudden overpressure or pressure reduction.



Acaloy Square Flush Case
This is a weather-proof case and ideal for use in symmetrical panels.

Sold RIGHT

Experienced HELICOID gage engineers are available to help you choose the gage you need. Distributors are conveniently located. Write for the name of the one nearest you.

ACCO
TRADE MARK

Helicoid Gage Division
AMERICAN CHAIN & CABLE
929-B Connecticut Avenue • Bridgeport 2, Connecticut

for Better Value

For more information circle **209** on inquiry card.

Advertisers' Index

INSTRUMENTS and AUTOMATION

A

A'G'A Division of Elastic Stop Nut Corp. of America 1352
Airborne Instruments Laboratory 1224
Alina Corporation 1367
All American Tool & Mfg. Co., Inc. 1352
Allegany Instrument Co., Inc. 1243, 1244
Alpha Metals, Inc. 1368
American Chain & Cable Co. 1369
American Machine and Metals, Inc. 1255
American Phenolic Corporation 1272, 1273
American Research Corporation 1284
Amther Testing Instrument Co., Inc. 1360
Analytical Measurements, Inc. ..... Inside Back Cover
Annin Company 1237
Applied Research Labs 1243
Arnoux Corporation 1301
Art Wire and Stamping Company 1300
Askania Regulator Company 1253
Assembly Products, Inc. 1246
Atomic Instrument Co. 1358
Automatic Electric Mfg. Co. 1237
Automatic Electric Sales Corporation 1216
Automatic Switch Co. 1172
Automatic Temperature Control Co., Inc. 1244

B

Bailey Meter Company 1200-1201
Baldwin-Lima-Hamilton Corp. 1181
Barber-Colman Company 1279, 1281
Barber-Colman Company, Wheelco Instruments Division 1277
Barksdale Valves 1198
Barton Instrument Corp. 1271
Beckman, Inc., Arnold O. 1289
Bendix Aviation Corp. 1245, 1290, 1305
Berkeley Division, Beckman Instruments, Inc. 1281
Black, Sivalls & Bryson, Inc. ..... Inside Front Cover
Bopp & Reuther G.M.B.H. 1347
Borg Corporation, George W. 1219
Bourns Laboratories 1365
Bowser, Inc. 1235
Bristol Company 1182-1183, 1275
British Industries Corporation 1202
Brown Instruments Division of Minneapolis-Honeywell Regulator Co. 1166, 1268-1269
Bruno-New York Industries Corporation 1281
Burlington Instrument Co. 1292
Burroughs Corporation, Electronic Instruments Division 1291

C

Cambridge Instrument Company, Inc. 1197
Cannon Electric Co. 1253, 1260, 1345
Chace Co., W. M. 1294
Cinema Engineering Co. 1244
Cincinnati Div., Bendix 1305
Clare & Co., C. P. 1207
Clifton Precision Products Co., Inc. 1265
Commercial Research Laboratories, Inc. 1208
C.O.M.S.I.P. (Instrument Control Consultant) 1372
Conoflow Corporation 1177
Consolidated Engineering Corporation 1213, 1245, 1278, 1302, 1345
Cramer Co., Inc., R. W. 1354
Crawford Fitting Co. 1203, 1245
Crescent Insulated Wire & Cable Co. 1236

D

Dahl Company, George W. 1282
Daniel Orifice Fitting Co. 1246
Davis Instruments 1270
Daystrom Instrument 1228
Development Engineering Company 1354
DeZurik Shower Co. 1247
Dialight Corporation 1343
Doelcam, Division of Minneapolis-Honeywell Regulator Co. 1223
Driver-Harris Company 1245
du Pont de Nemours & Co., Inc., E. I. 1202
Durant Mfg. Co. 1255
Dyna-Labs Inc. 1367

E

Eagle Signal Corporation 1361
Eastern Air Devices, Inc. 1295
Electric Auto-Lite Company 1199
Electronic Associates Inc. 1306
Ellison Draft Gage Company 1351
Emery Co., A. H. 1296
Epic, Inc. 1351
Eppley Laboratory, Inc. 1254
Ercona Camera Corporation 1302
Exact Weight Scale Company 1204

F

Falstrom Company 1267
Farris Engineering Corporation 1170-1171
Fenwal Incorporated 1226
Fielden Instrument Division 1259
Ford Instrument Company 1355
Foxboro Company 1192-1193

G

Gallien & Son, R. P. 1246
General Electric Company 1168-1169
General Electric Company, X-Ray Department 1263
General Precision Equipment Corporation 1178-1179
General Precision Laboratory, Inc. 1180
Genisco Incorporated 1288
G-M Laboratories, Inc. 1350
Goldak Company 1247
Gordon Co., Claud S. 1285
Gow-Mac Instrument Co. 1214
Gray Instrument Company 1255, 1346
Green Instrument Company 1350
Gurley, W. & L. E. 1247

H

Hammel-Dahl Company ..... Back Cover
Hasler-Tel Company 1350
Hathaway Instrument Company 1248, 1297
Heat-Timer Corporation 1252
Heise Bourdon Tube Company, Inc. 1293
Heitz, Inc., Carl 1248
Helco Products Corporation 1349
Helicoid Gage Division 1369
Hodgson Co., R. W. 1372
Hoke Incorporated 1357
Houston Technical Laboratories 1286
Hughes Research & Development Laboratories 1347
Hycon Mfg. Company 1261

I

Ideal-Aerosmith, Inc. 1248
Illinois Testing Laboratories, Inc. 1247
Industrial Instrument Corp. 1343
Instrof Incorporated 1276
International Rectifier Corporation 1252

J

Jackson Co., Byron 1231
Jessup Engineering and Development Company (Instrument Control Consultant) 1372
Johnson Engineering Company, Inc. Welton V. 1348
Joy Manufacturing Company 1186

K

Karn Chemical Equipment Company 1360
Kearfott Company, Inc. 1249, 1283
Kenyon Transformer Co., Inc. 1348
Kollmorgen Optical Corporation 1289
Kollsman Instrument Corporation 1187

L

Leeds & Northrup Co. 1240
Leslie Co. 1222
Levin & Son, Inc., Louis 1347
Lewis Engineering Co. 1184
Librascope, Incorporated 1248
Logan Engineering Co. 1214
Logistics Research, Inc. 1362
Los Angeles Scientific Instrument Co. 1346

M

Mack Electric Devices, Inc. 1372
MacKenzie Walton Co. 1349
Magnetic Metals Company 1299
Mallory & Co., Inc., P. R. 1230
Mann Co., Wm. I. 1249
Manning, Maxwell & Moore, Inc. 1220
Marsh Instrument Co. 1348
Marshalltown Manufacturing Co. 1218
Mercoid Corporation 1249
Meta-Magnet Associates 1372
Midwestern Instruments 1205
Minneapolis-Honeywell Regulator Co., Industrial Division 1166, 1268-1269
Moeller Instrument Company 1217
Monsell Company, John R. 1364

N

Nash Engineering Company 1238
North American Instruments, Inc. 1248

O

Offner Electronics Inc. 1337
Optical Coating Laboratory, Inc. 1251

P

Palmer Thermometers, Inc. 1286
Panellit, Inc. 1225
Penn Instruments Division of Burgess Manning Company 1188-1189
Phoenix Precision Instrument Co. 1271, 1368
Potter Aeronautical Company 1227
Potter Instrument Company, Inc. 1349
Preis Engraving Machine Co., H. P. 1360
Pritchard & Co. of California, J. F. 1229
P-W Industries, Inc. 1366
Pyrometer Instrument Company 1336

R

Rahm Instruments, Inc. 1301
Reeves Instrument Corporation 1165
Republic Aviation 1342
Rex Rheostat Co. 1372
Richard Rimbach Associates ..... 1209, 1210, 1211 & 1212
Rochester Manufacturing Company, Inc. 1303
Royson Engineering 1362

S

Scam Instrument Corporation 1358
Scherr Optical Tools, Inc., Geo. 1342
Schutte and Koerting Company 1233
Servomechanisms, Inc. 1206
Shallcross Manufacturing Co. 1257
Shore Instrument & Mfg. Co., Inc. 1366
Simplex Valve & Meter Co., Inc. 1303
Smith Co., S. Morgan 1353
Sorenson & Co., Inc. 1195
Southern Electronics Corporation 1285
Southwestern Industrial Electronics Co. 1355
Sprague Engineering Corporation 1218
Standard Electric Time Company 1232
Statham Development Corporation 1250
Statham Laboratories 1264
Sticht Co., Inc., Herman, H. 1362, 1364
Streeter-Amet Co. 1251
Sturtevant Co., P. A. 1366
Swartwout Company ..... 1173, 1174, 1175 & 1176

T

Taller & Cooper, Inc. 1336
Technology Instrument Corp. 1353
Tensitron, Inc. 1279
Texas Instruments Incorporated 1221
Thermo Electric Co., Inc. 1359
Tigerman Engineering Company 1346
Trimount Instrument Company 1280

U

Uehling Instrument Co. 1371
Unertl Optical Co., John 1250
Unistrut Products Co. 1254
United States Gauge, Div. of American Machine & Metals, Inc. 1255
United States Radium Corporation 1292

V

Vapor Recovery Systems Company 1363
Veeder-Root Incorporated 1234
Viking Electric 1336

W

Wallace & Tiernan Incorporated 1215
Warren Electronics Inc. 1298
Waterman Products Co., Inc. 1190-1191
Waugh Engineering Co. 1254
Weckesser Co. 1364
Weksler Thermometer Corporation 1258
West Instrument Corporation 1290
Western Gear Works 1196
Weston Electrical Instrument Corporation 1239
Wheelco Instruments Div., Barber-Colman Company 1277
Winzeler Manufacturing & Tool Co. 1351

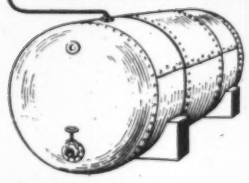
Z

Zeiss, Inc., Carl 1368

UEHLING INSTRUMENT COMPANY

470 Getty Avenue, Paterson 3, New Jersey
Recording, Indicating and Control Apparatus

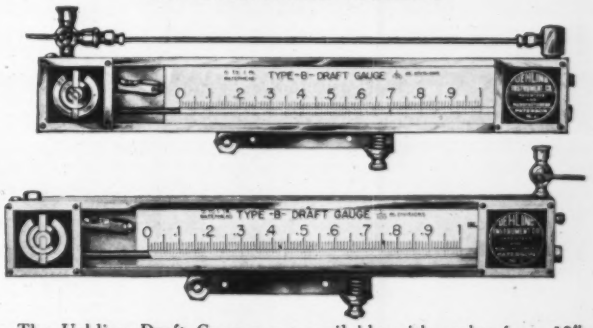
UEHLING TANK-O-METER



FOR MEASURING
LIQUID LEVELS
AND
TANK CONTENTS
ANY DISTANCE AWAY

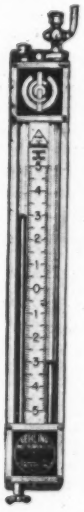
TANK-O-METERS may be applied to the measurement of ACIDS, ALKALIS, WATER, OIL, GASOLINE, ALCOHOL, BEVERAGES, TAR, MOLASSES, MILK, PAINTS, VARNISHES, SODIUM SILICATE, SOLVENTS, OR ANY OTHER CHEMICAL SOLUTION. *Send for Bulletin No.* 945.

INCLINED DRAFT GAUGES
For Plus or Minus Pressure
For Differential Pressure



The Uehling Draft Gauges are available with scales from 10" to 40" and waterheads ranging from 1" to 8". Scales are graduated for every 1/100" of waterhead. Each instrument is housed in a durable aluminum case with glass front and adjustable scale. They are extremely accurate as each instrument is individually calibrated. Furnished for draft, pressure, or differential pressure. *Send for Bulletin* 1146.

U-TUBES
(STRAIGHT TUBE TYPE)



Uehling U-Tube Pressure and Vacuum Gauges consist of straight Pyrex tubes with a bottom metal connecting base, housed in aluminum case with glass front.

Each instrument has an external micrometer scale adjustment, zero check cock, and drain valve.

Scale lengths from 10" to 100".

Four indicating fluids.

Special calibration on request.

Send for Bulletin 828.

PRESSURE AND VACUUM GAUGES

Meet the most exacting requirements and combine accuracy, reliability, simplicity and durability. Housed in durable Aluminum cases with glass fronts. Standard instrument covers a range of 31 inches of mercury head. A catch-all for trapping visibly shows any condensate in the connecting line. Each scale has a knurled micrometer screw adjustment. A simple means is provided for cleaning the Pyrex manometer. May be calibrated in any desired units for pressure or vacuum and may be provided with a plus or minus scale to read either vacuum or pressure on the same instrument. Length to suit any range. Greater flexibility is made possible by choice of either mercury or one of three other indicating fluids.

Send for Bulletin 147.

MERCURY COLUMN ABSOLUTE PRESSURE INDICATORS

Uehling Mercury Column Absolute Pressure Gauges are designed for exacting requirements of modern engineering practice, and combine accuracy, reliability, simplicity, and durability. Used with all processes where extremely accurate absolute pressure determinations are essential. Can furnish catch-all for trapping and showing any condensate. Standard scale lengths of 7" to 100", graduated in 1/10" of mercury absolute pressure or in pounds or in equivalent metric units.

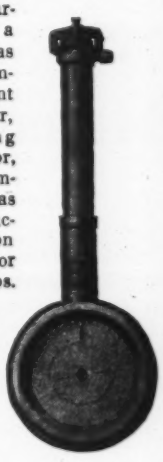
Send for Bulletin 247.

TEL-FLO METER

For measuring flow rates and purging line. Are accurate, exceptionally durable, and attractive. Housed in aluminum case with plastic front to protect graduated glass tube. Can be furnished in aluminum, brass, or stainless steel bodies (or any other metal). Suitable for maximum pressures of 300 lbs. Higher pressures upon request. Furnished with or without control valve and with either top, side, or back connection.

Send for Bulletin 553.

APEX CO_2 RECORDER



Actuated by changing partial vacuum developed in a separate device, known as the CO_2 meter. The complete standard equipment consists of one CO_2 Meter, one type M Recording Gauge, one type Z Indicator, "Pyro-Porus" filter, one sampling pipe holder, one gas dryer, one motor driven vacuum pump and one suction regulator. Where steam or water is available at 60 lbs. pressure or more, an aspirator may be substituted for the motor driven vacuum pump which materially reduces the price of the equipment. The Apex CO_2 Recorder makes a continuous record.

Send for Bulletins 118 *and* 118E.

COMBINED BAROMETER AND VACUUM RECORDER

Records barometric pressure and vacuum on same chart. Distance between the two recorded lines represents the absolute pressure. Permanent accuracy and remarkable legibility are the outstanding characteristics of this recorder. Accuracy is obtained by the employment of the mercury column principle and consequently this recorder has the same high degree of accuracy as the mercury column indicator. It employs no springs, diaphragms, or multiplying levers, therefore holds its calibration permanently without readjustment.

Send for Bulletin 150.

MERCURIAL BAROMETERS

With vernier scale. Can be furnished with the same style case as used with Uehling pressure and vacuum gauges, illustrated here.

UEHLING VACUUM RECORDER

Same as above, without barometric pen.

Send for Bulletin 140.

For more information circle **210** on inquiry card.

SEARCHLITE SECTION

CLASSIFIED ADVERTISING
EMPLOYMENT & BUSINESS OPPORTUNITIES

The advertising rate is $12.00 per inch for all advertising (An advertising inch is measured 7/8 inch vertically by 2 1/4 inches wide.)

Send advertisements to INSTRUMENTS & AUTOMATION, 845 Ridge Ave., Pittsburgh 12, Pa.

Address box replies to Instruments Publishing Co., 845 Ridge Ave, Pittsburgh 12, Pa.

ELECTRICAL ENGINEER

Opening for electrical engineer in electrical-instrument department of a progressive chemical-plastic company currently undertaking a multi-million dollar expansion program.

This job requires an energetic man with a strong technical background and creative ability who is interested in the rapidly growing instrumentation field in the chemical industry. Plant located in pleasant New England community. Send resume and salary requirements to Box No. 298. Replies strictly confidential.

For more information circle **214** on inquiry card.

For more information circle **211** on inquiry card.

Mack
MERCURY RELAYS
Specified By Particular Engineers
hermetically sealed • no exposed arc • one moving part • silent • compact • motor loads to 2 hp., current loads to 35 amp • safeguards your application.
MACK ELECTRIC DEVICES, INC.
31 Glenside Ave., Wyncote, Pa.

For more information circle **215** on inquiry card.

*SALES???

Instrumentation and Electronic lines wanted by manufacturers' Agency with Southern California following in Aircraft, Guided Missile and Military Circles.

R. W. HODGSON CO.
Technical Sales Representation & Research & Development Engineering
3406 W. Washington Blvd. L. A. 18, Calif.
REpublic 2-2651

For more information circle **212** on inquiry card.

META-MAGNET

The patented a.c. electromagnet that attracts nonferrous metals. Adaptation suggested for automation, sorting and handling, recovery of scrap, etc. Demonstration model operates from 115v 60 cycle circuit picks up half dollar. $41.50 prepaid. Also desk model electromagnetic mineral separator for weakly magnetic minerals, operates on 115v 60 cycle. $75.00 prepaid. Literature.

META-MAGNET ASSOCIATES—P.O. Box 775, Sanford, Florida

For more information circle **216** on inquiry card.

C.O.M.S.I.P.

Specialized in control Engineering
Instrument layout—Procurement—Application—conventional and graphic panel design and construction

INSTALLATION—REVAMPING
STARTING UP—MAINTENANCE

40 Ave. Verdun • Croissy • S&O France

For more information circle **213** on inquiry card.

TOP FLIGHT SALES ENGINEERING REPRESENTATION AVAILABLE

•

Electronic Specialists

Competent, aggressive, well established manufacturers' representatives with excellent sales and application engineering record, seek additional capable principal in electronic instrumentation, automation, computers. Territory: New York, New Jersey, Eastern Penna.

Wire or write to Box 299.

Representative will be at ISA Exhibit

NEW LITERATURE

Kemp Mfg. Co., 405 E. Oliver St., Baltimore 2, Md.

Circle **665** on inquiry card.

Line Strainer. New 4-page Bulletin 240 describes maker's "Straitflo" strainer for pressures up to 150 psi. —Hays Mfg. Co., W. 12th St., Erie, Pa.

Circle **666** on inquiry card.

Filter Driers. New 6-page Booklet TD110 describes 6-point protection offered by maker's "Trap-Dri" filter driers.—A-P Control Corp., 2450 N. 32nd St., Milwaukee 45, Wis.

Circle **667** on inquiry card.

TUBING

Tube Fittings. New 12-page Catalog 4324 presents maker's complete line of "Intru-lok" flareless tube fittings.—Tube & Hose Fittings Div., The Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

Circle **668** on inquiry card.

Power Tube-flarer. New 8-page Catalog 1145A12 describes maker's "Model 232B" power tube-flarer. Includes operating instructions for flaring, squaring, burring, and beading. —Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

Circle **669** on inquiry card.

Steel Tubing. New 6-page Bulletin 39 describes maker's hydraulic-quality, low-carbon steel tubing. Includes tables on working pressures, bursting pressures, minimum bend radii, etc.—Superior Tube Co., Norristown, Pa.

Circle **670** on inquiry card.

Plastic Tubing. New 8-page catalog presents maker's extruded plastic tubing and resinous sheeting and tape for electrical insulating purposes.—Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill.

Circle **671** on inquiry card.

MATERIALS

Magnetic Alloys. New 8-page descriptive bulletin outlines latest manufacturing methods employed in field of high-permeability magnetic alloys. —Stanat Mfg. Co., Inc., 47-28 37th St., Long Island City 1, N. Y.

Circle **672** on inquiry card.

Disulfide Lubricants. New 4-page brochure describes development of maker's line of molybdenum-disulfide lubricants.—Alpha Molykote Corp., 65 Harvard Ave., Stamford, Conn.

Circle **673** on inquiry card.

Casting Resin. New 2-page Bulletin 7-2-10 describes maker's "Stycast 2651, 2340M, TPM-2 & 1090" casting resins.—Emerson & Cuming, Inc., 869 Washington St., Canton, Mass.

Circle **674** on inquiry card.

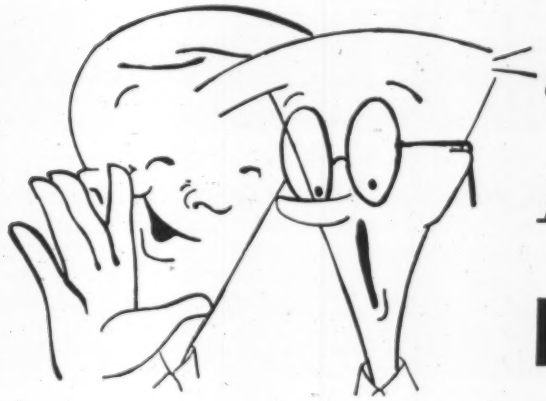
GAUGE & INSTRUMENT CONTROLLED AUTOMATION

Your present machines can be equipped with full automation, including automatic loading and gauge feedback control of size.

SPECIALISTS IN CENTERLESS GRINDER AUTOMATION.

Jessup Eng. & Dev. Co. "JEDCO" 3980 Superior Ave. Cincinnati 36, Ohio

For more information circle **217** on inquiry card.



"No foolin'... a 1-year subscription to

INSTRUMENTS and AUTOMATION

brings you more than 2000 pages of instrumentation data for as little as $4.00 per year, or less!"

Details on next page

Use This Subscription Card ➧

Readers' Inquiry Card ➧

For further details concerning developments reported in advertisements, or New Product or New Literature reviews, CIRCLE THE NUMBER corresponding to that which appears with the ad or write-up.

When indicating change of address, kindly note old address.

SPECIAL NOTICE

This reply card is only for use in the USA and Canada. Requests from foreign firms should be sent direct to the manufacturer.

INSTRUMENTS PUBLISHING CO.
845 Ridge Avenue, Pittsburgh 12, Pa.

Please enter the following subscriptions and bill me (Company) at .....

Signed .....

Address .....

Name ..... Position.....
Company .....
Products Manufactured .....
Address .....

Name ..... Position.....
Company .....
Products Manufactured .....
Address .....

Name ..... Position.....
Company .....
Products Manufactured .....
Address .....

Name ..... Position.....
Company .....
Products Manufactured .....
Address .....

Name ..... Position.....
Company .....
Products Manufactured .....
Address .....

For additional names use another sheet

A

Print—fill in COMPLETELY:

INSTRUMENTS and AUTOMATION
August '55
Good until 11-1-55

Name ..... **Title**.....

Company .....

Company Address .....**City** .....**Zone** .....**State** .....

Products Manufactured .....

☐ **Check for address change. Show OLD address here:**.....

Advertised Products

1	21	41	61	81	101	121	141	161	181	201	221
2	22	42	62	82	102	122	142	162	182	202	222
3	23	43	63	83	103	123	143	163	183	203	223
4	24	44	64	84	104	124	144	164	184	204	224
5	25	45	65	85	105	125	145	165	185	205	225
6	26	46	66	86	106	126	146	166	186	206	
7	27	47	67	87	107	127	147	167	187	207	
8	28	48	68	88	108	128	148	168	188	208	
9	29	49	69	89	109	129	149	169	189	209	
10	30	50	70	90	110	130	150	170	190	210	
11	31	51	71	91	111	131	151	171	191	211	
12	32	52	72	92	112	132	152	172	192	212	
13	33	53	73	93	113	133	153	173	193	213	
14	34	54	74	94	114	134	154	174	194	214	
15	35	55	75	95	115	135	155	175	195	215	
16	36	56	76	96	116	136	156	176	196	216	
17	37	57	77	97	117	137	157	177	197	217	
18	38	58	78	98	118	138	158	178	198	218	
19	39	59	79	99	119	139	159	179	199	219	
20	40	60	80	100	120	140	160	180	200	220	

New Instruments

301	321	341	361	381	401	421	441	
302	322	342	362	382	402	422	442	
303	323	343	363	383	403	423	443	
304	324	344	364	384	404	424	444	
305	325	345	365	385	405	425	445	
306	326	346	366	386	406	426	446	
307	327	347	367	387	407	427	447	
308	328	348	368	388	408	428	448	
309	329	349	369	389	409	429	449	
310	330	350	370	390	410	430	450	
311	331	351	371	391	411	431	451	
312	332	352	372	392	412	432	452	
313	333	353	373	393	413	433	453	
314	334	354	374	394	414	434	454	
315	335	355	375	395	415	435	455	
316	336	356	376	396	416	436	456	
317	337	357	377	397	417	437		
318	338	358	378	398	418	438		
319	339	359	379	399	419	439		
320	340	360	380	400	420	440		

New Literature

501	521	541	561	581	601	621	641	661
502	522	542	562	582	602	622	642	662
503	523	543	563	583	603	623	643	663
504	524	544	564	584	604	624	644	664
505	525	545	565	585	605	625	645	665
506	526	546	566	586	606	626	646	666
507	527	547	567	587	607	627	647	667
508	528	548	568	588	608	628	648	668
509	529	549	569	589	609	629	649	669
510	530	550	570	590	610	630	650	670
511	531	551	571	591	611	631	651	671
512	532	552	572	592	612	632	652	672
513	533	553	573	593	613	633	653	673
514	534	554	574	594	614	634	654	674
515	535	555	575	595	615	635	655	
516	536	556	576	596	616	636	656	
517	537	557	577	597	617	637	657	
518	538	558	578	598	618	638	658	
519	539	559	579	599	619	639	659	
520	540	560	580	600	620	640	660	

why just keep abreast—
when you can keep ahead

of the latest developments in

AUTOMATION
INSTRUMENTATION
AUTOMATIC CONTROL

read
INSTRUMENTS and AUTOMATION

—for 28 years the world's leading magazine of measurement and control

In one year I & A brings You more than

- 2000 pages of instrumentation data.
- 2000 reviews of new instruments.
- 2000 indexed literature items.
- 2000 indexed listings of instrument manufacturers and their products.

The regular subscription price is $4.00. BUT:

On two or more new subscriptions or renewals sent together on one order the rates will be reduced as follows:

2 separate one-year subscriptions	$ 6.00
3 separate one-year subscriptions	7.50
4 separate one-year subscriptions	9.00
5 separate one-year subscriptions	10.00

Offer good only in U. S. and Canada.
For rates to other countries see page 1167.

FIRST CLASS
PERMIT No. 1441
(Sec. 34.9 P.L.&R.)
PITTSBURGH, PA.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

3c POSTAGE WILL BE PAID BY—

INSTRUMENTS and AUTOMATION
(Instruments Publishing Co., Inc.)
845 Ridge Avenue
Pittsburgh 12, Pa.

FIRST CLASS
PERMIT No. 1441
(Sec. 34.9 P.L.&R.)
PITTSBURGH, PA.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

3c POSTAGE WILL BE PAID BY—

INSTRUMENTS and AUTOMATION
(Instruments Publishing Co., Inc.)
845 Ridge Avenue
Pittsburgh 12, Pa.

check your pH recorders on the spot INSTANTLY... ANYWHERE

Obtain accurate uninterrupted operation of pH recorders and controllers by using this simple, direct reading pH meter and Probe Unit for periodical on-the-spot checks with no interruptions or waiting time for samples sent to the laboratory.

This Probe Unit can be inserted directly into grounded tank or stream for quick and accurate pH readings with no grab samples. Electrode system is combined in one unit and protected by polyethylene shield so that breakage is eliminated.

Simple one knob control on pH meter permits use by untrained personnel.

Electronic circuitry reduced to simplest form by employing one electrometer tube with consequent small battery requirements, providing operation up to two years with four hours weekly use.

complete **$125.00**

Instrument size: 3 x 5⅞ x 2¼ inches
Case size: 3¾ x 6½ x 4⅛ inches
Weight with accessories: 3 lbs.

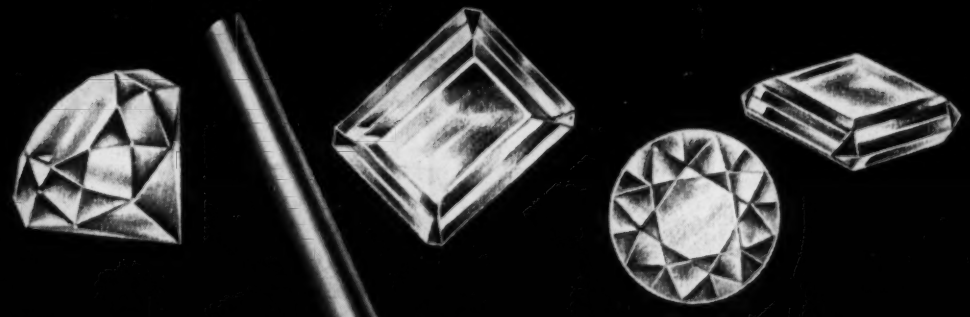
Completely self-contained in water-proof ever-ready case with shoulder strap.

Analytical Measurements, Inc.
331 MAIN STREET • CHATHAM, NEW JERSEY

SEE US IN BOOTH A167

For more information circle **218** on inquiry card.

The Problem Couldn't Wait . . .



for Tremendous Man-Made Diamonds

TUNGSTEN CARBIDE SPLINE TRIM....

close to diamonds in hardness has added ten new sizes to the famous H-D MICROFLO VALVES for LOW

LOW FLOWS

- Twenty-five interchangeable plug sizes
- Rangeability of each size 50:1, or better
- Cv = 0.63 (MAX.) to Cv = 0.0000002 (MIN.)
- Working pressures to 15,000 psi at 100°F.

Conversion of Flow Coefficient Cv to Cubic Centimeters

TRIM SIZE	Cv (MAX.)	CCPM
1	0.63	2385
2	0.40	1514
3	0.25	946
4	0.16	605
5	0.10	378
6	0.063	238.5
7	0.040	151.4
8	0.025	94.6
9	0.016	60.5
10	0.010	37.8
11	0.0063	23.85
12	0.0040	15.14
13	0.0025	9.46
14	0.0016	6.05
15	0.0010	3.78
16	0.00063	2.38
17	0.00040	1.514
18	0.00025	0.946
19	0.00016	0.605
20	0.00010	0.378
21	0.000063	0.2385
22	0.000040	0.1514
23	0.000025	0.0946
24	0.000016	0.0605
25	0.000010	0.0378

HAMMEL-DAHL COMPANY

175 POST ROAD (Warwick Industrial Park)
PROVIDENCE 5, R. I., U. S. A.
SALES OFFICES IN ALL PRINCIPAL CITIES
MANUFACTURING PLANTS IN WARWICK, R. I., U. S. A., CANADA, ENGLAND, FRANCE AND HOLLAND
CANADIAN MANUFACTURING AFFILIATE
GUELPH ENGINEERING CO., GUELPH, ONT.

VISIT OUR BOOTH 421-422-423, I. S. A. EXHIBIT, LOS ANGELES, SEPT. 12-16.

For more information circle **219** on inquiry card.